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THE NORTHWESTERN CONVENTION.

In the last issue of the ELECTRICAL REVIEW the recent meeting of the Northwestern Electrical Association, at Milwaukee, Wis., was fully reported. It is always a pleasure to attend one of these meetings, or to read an account of the proceedings, because of the practical character of the papers and discussions which are presented at them, and the earnestness with which the members discuss the business in hand when they are assembled in their semi-annual gathering. No one can doubt that the Northwestern Electrical Association has been of high value to its members and that it has greatly advanced the business of electric lighting in that region of the country to which its membership is limited.

ELECTRICITY ON THE RAILWAY.

While we are waiting for the definite electrical equipment of main-line railways there is a very considerable field for the application of electricity to railway work other than for the actual propulsion of trains. Attention was called in these columns some weeks ago to the necessity for steam railway managers training electrical engineers in order that, when the time comes for the traction equipment to go on, they will have staffs of men familiar both with the electrical problems involved and with the practical conduct of railways. The importance of thus training men should certainly commend the idea to the governing powers of our railway systems.

Among the important uses to which electricity is applied on railways of the most modern type may be mentioned signaling, the movement of switches, the lighting of signals and switches, telegraphing, and the electric lighting of trains. With most of the first-mentioned uses the progress of development has reached a point of considerable perfection, but in the lighting of trains there seems to have been, in this country at least, some conservative prejudice that has made the equipment of passenger cars with electric lights rather more slow than the perfection of the art of train lighting would warrant. To the casual observer it might not occur that the lighting of railway trains is a matter of much importance, or that it entails much expense upon railway management. This is distinctly a wrong view of the matter, because the expense of lighting a single ordinary passenger car by gas, under the best and most economical systems of gas lighting now in vogue, amounts to several hundred dollars per annum. Both the comfort and safety of the passenger are insured by the use of electric lights, whereas it has been demonstrated that cars may be lighted electrically at less cost for the maintenance of the system and supplies consumed than in any other way that has been attempted. Electric light is said to be even cheaper than kerosene oil, and it is infinitely more satisfactory.

There was an agitation in a large number of the states of the Union several years ago, following upon several dreadful railway disasters in which wrecked trains were set afire from stoves carried in the cars, and the result was legislation practically putting the car-stove out of business, and making it an offense punishable by law for railways to transport passengers in cars heated with these dangerous appliances. It is about time, if an enlightened public sentiment can be brought to bear upon the question, to commence a similar agitation against the highly dangerous lighting systems now employed by some railroads. In all of the oil and gas-lighting systems naked flames are used, while there is necessarily carried on the car a reservoir of inflammable liquids or gases. To insure, as far as may be, the safety of passengers, requires that every variety of flame-making and inflammable substance should be rigidly excluded from cars which may at some time be wrecked. If the car-stove was bad, certainly the car-gas tank or oil lamp is no better.

When, to the considerations of safety which are present in electrical installations are added those of economy, and also the satisfaction given the patrons of the railway by the adoption of a better, steadier and more modern light, it becomes difficult to see how the general introduction of electric-car lighting can much longer be delayed. The experience of those railways which have adopted electric train lighting on some of their finer trains has been highly satisfactory and certainly such as to encourage other railways to proceed in the same progressive direction.

TELEPHONE IMPROVEMENTS AND COPPER.

It is stated on the authority of a well-known financial journal that the appearance of technical descriptions of Dr. Pupin's recent inventions for the betterment of electric circuits has caused a feeling in mining and speculative circles that the necessity for copper in telephone circuits has been done away with.

On the contrary, it is quite probable that important extensions of the use of the telephone and telegraph will follow directly upon the exploitation of better methods for constructing electric circuits, and that instead of reducing the demand for copper they will actually increase it. The particular patents referred to do not in any way contemplate the substitution of other materials for copper in telephone lines, especially long ones. Indeed it is probable that copper will hold its own as a conducting metal longest in telephone work, on account of the peculiar difficulties encountered by the telephone when talking through lines of great capacity. As everybody knows, the same conductivity may be obtained on a given line of another metal by making the wire larger, but coupled with this increase of size comes an increase of the electrostatic capacity of the line, and this is a much more serious difficulty to encounter than resistance. While Dr. Pupin's invention enables the balancing out of capacity effects by introducing reacting coils, it is not likely that telephone lines will be built of metals involving directly an increase in capacity necessitating more and larger coils for compensation. The telephone people will not increase the evil in order to cure it; hence the fears of the copper miners have really no foundation.

WASTED THERMAL UNITS.

Every day as we look out of the windows of the ELECTRICAL REVIEW offices our eyes are greeted by the painful spectacle of a tremendous power going to waste. From the exhaust heads of a large power-station nearby there pours up into the air an immense volume of white vapor which has been used as steam in the engines below and which is still capable of doing a considerable amount of work if properly utilized.

It so happens that the exigencies of the situation of the particular station referred to are such that it can not conveniently condense its exhaust steam. This is thrown away into the atmosphere as if it were of no value whatever. In the surrounding neighborhood it could be utilized for steam heat through several months of the year. Used in the boilers of sulphurous acid engines or carbon bisulphide engines, as has been suggested in certain recent German engineering work, it could be made to exert a very large amount of useful effort. Even condensed and sold as hot water it would do some good to somebody.

People are prone to forget that when steam has expanded in the engine from boiler pressures to a little more than atmospheric pressure it still has left within it a large degree of potential energy. There are systems for utilizing this and making it available, but they have far too little use. The ordinary electric light or railway station, especially if of small size and located where condensing water is difficult to obtain, cheerfully throws away exhaust steam to the amount of many dollars annually. It is curious that this should be done in face of the fact that there are excellent systems for condensing, using a minimum of water, and that there are other systems for selling directly hot steam after it has been used in the engine.

THE QUEEN.

The lamented death of the Queen has gone far to exhibit the closeness of the fraternal feeling of the great nations on the two sides of the Atlantic. Perhaps the universal sorrow with which Americans learned of the passing away of this venerable and respected woman and well-beloved sovereign may be, in the words of the first transatlantic cable message—sent by the Queen to President Buchanan, August 16, 1858—"an additional link between the nations whose friendship is founded on their common interest and reciprocal esteem." Her long reign was marked by a glorious advance of the whole English-speaking world in all the arts of peace. By her initiative and example much was done to promote conditions under which science and industry could flourish, while her patronage was extended to the advancement of commerce, education and research. While our British friends feel her loss as a personal bereavement, they may also take pride that their race has produced a character so exemplary, a ruler so wise and a type of womanhood so universally respected and beloved.

When the telephone system in our larger cities began to grow patrons were more and more frequently annoyed by the statement "busy" when they called up somebody. As the telephone grew into more general use lines became busy oftener, and the word "busy" was regarded as a sort of bane of the system, necessary to endure but none the less to be sworn at each time it was heard.

Nowadays, when no important concern is without a number of lines connecting its local exchange with the central exchange, we are frequently informed that the man to whom we wish to speak is "talking over the other wire." It may be just as bad as "busy," but it seems to be the latest unavoidable development of telephony.

Very few people who use the telephone consider its true function in offices. The telephone is a door through which comes large business, many inquiries, and at which all sorts and conditions of people present themselves. In many business houses, where it would never for a moment be permitted that the front door should be attended by other than a skillful and courteous person ready and able to attend to customers and visitors politely and promptly, the telephone is put in charge of some ignorant person and often somebody who is destitute of the first principles of good manners. It is hard to see why one should not receive the same courtesy and attention when he presents himself indirectly by the telephone or actually in the body at his correspondent's place of business. Too little attention has been given to the employment of clerks to answer the telephone, and many employers have apparently forgotten that the telephone is an open door and that it should be guarded by a person of intelligence, discretion and good manners.

THE THEORY OF ALTERNATING DYNAMO ELECTRIC MECHANISMS—XIII.

BY W. ELWELL GOLDSBOROUGH.

Equation (142) shows that E_c lags 90° behind the current, and that its value may be expressed in terms of the capacity of the condenser, the angular velocity and the maximum value of the current, since when,—

$$\sin(\omega t + \phi - 90°) = 1$$

e will have attained its maximum value E_c,—

$$e_{c_{max}} = E_c = \frac{I}{C\omega}. \qquad (143)$$

The value of I can be expressed in terms of E and the dimensions of the circuit, for, since in Fig. 33, $OC = r\ I$ and $CA = I \div C\omega$, therefore:—

$$E = I\sqrt{r^2 + \frac{1}{C^2\omega^2}} \qquad (144)$$

and,

$$I = \frac{E}{\sqrt{r^2 + \frac{1}{C^2\omega^2}}} \qquad (145)$$

The value of the angle of advance depends directly upon the dimensions of the circuit, since the tangent of the angle AOC $= (1 \div C\omega) \div (r\ I) = 1 \div C\omega r$, therefore,—

$$\phi = \tan^{-1}\frac{1}{C\omega r} \qquad (146)$$

Combining equations (139), (145) and (146) we can finally obtain a more general expression for the current, since by the substitution of (145) and (146) in (139) we get,—

$$i = \frac{E}{\sqrt{r^2 + \frac{1}{C^2\omega^2}}}\sin\left(\omega t + \tan^{-1}\frac{1}{C\omega r}\right) \qquad (147)$$

This is the form most commonly given to the equation expressing the instantaneous value of the current. It can be derived by the direct integration of the fundamental equation of electro-motive forces acting in a circuit containing resistance and capacity, which is generally expressed in the [1]form,—

$$e = r\,i + \int\frac{i\,dt}{C} \qquad (148)$$

To obtain an expression for the instantaneous value of the charge in the condenser at any time (t), we have only to integrate equation (147), since $i = dq \div dt$; therefore,—

$$q = \frac{-E}{\omega\sqrt{r^2 + \frac{1}{C^2\omega^2}}}\cos\left(\omega t + \tan^{-1}\frac{1}{C\omega r}\right) \qquad (149)$$

$$= \frac{E}{\omega\sqrt{r^2 + \frac{1}{C^2\omega^2}}}\sin\left(\omega t + \tan^{-1}\frac{1}{C\omega r} - 90°\right). \qquad (150)$$

[1] For the direct integration of (161) see Bedell and Crehore's Alternating Current, chap. 5, page 71.

If we examine the radical in (144) and (147) we see it is the square root of the sum of two squares. We can, therefore, represent it as the square hypothenuse of a right angle triangle O a c, in Fig. 34, if we lay off the base O $c = r$ and the side $c\ a = 1 \div C\omega$. By comparing Figs. 33 and 34 the angles AOC and a O c are seen to be equal, since the tangent of each equals $1 \div C\omega r$. In fact Fig. 34 can be obtained from Fig. 33 by dividing each of its sides by (I) the maximum value of the current. Fig. 34 is, therefore, the

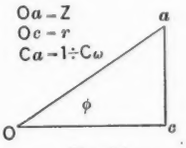


Fig. 34

FIG. 34.—ALTERNATING MECHANISMS

triangle of resistances corresponding to the electro-motive-force triangle of Fig. 33. The radical

$$\left(\sqrt{r^2 + \frac{1}{C^2\omega^2}}\right) = z$$

is called the "effective resistance" of the circuit or the *impedance*, and its value is expressed in ohms. (r) is the ohmic resistance of the circuit. ($1 \div C\omega$) is called the *reactance* of the circuit, and its value is expressed in ohms, and is denoted by the letter (x). Therefore

$$z = \sqrt{r^2 + x^2} \qquad (151)$$

The Chamber of Delegates of the Chicago International Electrical Congress adopted: As a unit of capacity the *international farad*, which is the capacity of a condenser charged to a potential of one international volt by one international coulomb of electricity. For purposes of measurement the *international microfarad*, or the .000001 part of an *international farad*, is used because of the very great size of a farad.

Example No. 6.

Given: A circuit similar to that shown in Fig. 32, consisting of a non-inductive line, each half of which has a resistance of .75 ohm, connecting the terminals of an alternator with the terminals of a mica insulated condenser. The alternator develops an electro-motive force that is a simple harmonic wave of 75 volts effective pressure and a frequency of N = 132. The condenser has a capacity of 4.846 microfarads.

What is the maximum value of the current flowing in the circuit? What is the value of the angle of advance of the current? What is the equation of the instantaneous current? What is the impedance, or the effective resistance of the circuit?

By equation (145) the maximum value of the current equals,—

$$I = \frac{75}{\sqrt{(7.5 + 7.5)^2 + \frac{1}{.000004846\,\omega}}} = .3009 \text{ ampere}$$

since $\frac{1}{C\omega} = 248.8$ ohms $= x$, and is the reactance of the circuit =

$$\frac{1}{C^2\omega^2} = 61908.0$$

$$r = 15.0 \text{ ohms}$$

$$r^2 = 225.0$$

$$z = \sqrt{225 + 61908} =$$

249.2 ohms, and is the impedance of the circuit.

Again, from equation (146),—

$$\phi = \tan^{-1}\frac{1}{C\omega r}, \text{ therefore,}$$

$$\cos\phi = \frac{r}{\sqrt{r^2 + \frac{1}{C^2\omega^2}}}$$

and, from (144), since the radical = E ÷ I,

$$\cos\phi = \frac{I\,r}{E}$$

therefore,— $\phi = 86°\ 33'$, or $= (86°\ 33') \div (57°\ 18') = 1.51$ radians, since a radian subtends an angle of 57° 17′ 44.8″, nearly.

Combining the above results,—

$i = .3009 \sin(829.4\,t + 1.51)$, from (147).

It is noticeable that z is but little greater than $\frac{1}{C\omega}$ and that the current is nearly 90° in advance of the impressed electro-motive force.

Furthermore, if the condenser terminals were short-circuited by a heavy copper wire the value of the current would immediately jump to five amperes.

ON CIRCUITS CONTAINING RESISTANCE, INDUCTANCE AND CAPACITY.

In alternating-current working there are three factors which determine the characteristics of each and every circuit, and each of the three is always present. If any one of the three factors is very large as compared with the other two, the latter may be neglected, and the characteristics of the circuit determined in terms of the dominant factor. Under no circumstances, however, can the circuit, theoretically, be freed from effects that are characteristic of each of the three factors, although for all practical purposes the illumination of any or all of the factors from the circuit is readily accomplished.

These factors are *resistance, inductance* and *capacity*.

Taken individually, we are already familiar with the effects which each of these factors produces, we also know the characteristic effects produced by any two

of them acting together; to broaden our view it remains to study the combined action of the three in influencing the value of the current and power developed in an alternating-current circuit.

As an example, take such a circuit as that shown in Fig. 35. Here we have a non-inductive resistance connected in series with an air core induction coil of negligible resistance, a condenser and an alternating-current generator.

Suppose that the electro-motive force developed by the generator is the simple harmonic wave,

$$e = \mathrm{E} \sin \omega t.$$

Suppose further that for the moment the induction coil and the condenser are removed from the circuit.

Then by (57) a current will be set up in the circuit that is a simple harmonic function of the time and expressed by the equation,

$$i = \frac{\mathrm{E}}{r} \sin (\omega t);$$

that is, the current will be in phase with the impressed electro-motive force.

Now consider another condition. Suppose that the non-inductive resistance and the condenser are removed from the circuit. The impressed electro-motive force will now be acting on the induction coil alone. The result will be by (59) that another simple harmonic current will flow in the circuit, although now it will be a lagging current. The phase angle between the electro-motive force and current will be (90°) and the equation of the current will be

$$i = \frac{\mathrm{E}}{\mathrm{L}\,\omega} \sin (\omega t - 90^\circ).$$

By a third arrangement the non-inductive resistance and the induction coil can be eliminated from the circuit. By (136), since the impressed electro-motive force is now acting on the condenser alone, the current in the circuit will be 90° in advance of the impressed electro-motive force, and bear the relation to it expressed by

$$i = \frac{\mathrm{E}}{\frac{1}{\mathrm{C}\,\omega}} \sin (\omega t + 90^\circ).$$

We see then that a simple harmonic electro-motive force acting on either one of the three principal parts of the circuit produces a harmonic current in that part of the circuit. It is also true that if a harmonic current is made to flow in the circuit shown in Fig. 35, when all of the elements are present, an electro-motive force will be apparent at the terminals of the non-inductive resistance that is in phase with the current. At the terminals of the induction coil will be found an electro-motive force that is 90° in advance of the current and at the terminals of the condenser an electro-motive force lagging 90° behind the current. Moreover, each of these electro-motive forces will be a sine function of the time.

To determine the value of the impressed electro-motive force, or of the electro-motive force required to set up the harmonic current in the circuit, the method developed on page 479, Fig. 3, is applied. The resultant of the ohmic electro-motive force, and the inductance electro-motive force may first be taken. This will give a harmonic electro-motive force of the same frequency, but differing in amplitude and phase from each of the component electro-motive forces. Finally, the resultant of this electro-motive force and the electro-motive force at the terminals of the condenser can be taken, given finally the required value of the impressed electro-motive force.

The impressed electro-motive force will be a harmonic electro-motive force (see page 509, Fig. 14) of the same frequency as the three component electro-motive forces, but of different amplitude from either of them and differing from them in phase.

Conversely, then, it may be stated that in order to set up a current in a circuit containing resistance, inductance and capacity, the impressed electro-motive force has to overcome the ohmic resistance of the circuit and the reactive resistances of inductance and capacity.

By Ohm's law we know that it requires an effective electro-motive force having a virtual value,

$$\mathrm{E}_r = \mathrm{I}\, r,$$

to overcome the ohmic resistance of the circuit and that this electro-motive force is in phase with the current.

We have also seen that the component of the impressed electro-motive force that overcomes the counter electro-motive force of the induction coil is 90° in advance of the current and that its maximum value is expressed by the equation,

$$\mathrm{E}_l = \mathrm{L}\,\omega\,\mathrm{I}. \qquad (52)$$

And that the component of the impressed electro-motive force that overcomes the electro-motive force resulting from the charge of electricity which is alternately given to and removed from the condenser plates as the current oscillates, lags 90° behind the current and that its maximum value is expressed by the equation,

$$\mathrm{E}_c = \frac{\mathrm{I}}{\mathrm{C}\,\omega}. \qquad (143)$$

Therefore, since the wave of the inductance electro-motive force of the induction coil is 90° in advance of the current and the reactive electro-motive force of the condenser lags 90° behind the current, they must differ in phase by 180°, and are consequently diametrically opposed to one another. The resultant of the two reactive electro-motive forces will therefore have a value that is equal to the difference of E_c and E_e, or the maximum value of the reactive electro-motive force of the circuit is

$$\mathrm{E}_x = \mathrm{E}_c - \mathrm{E}_l = \mathrm{I}\left(\frac{1}{\mathrm{C}\,\omega} - \mathrm{L}\,\omega\right) \qquad (152)$$

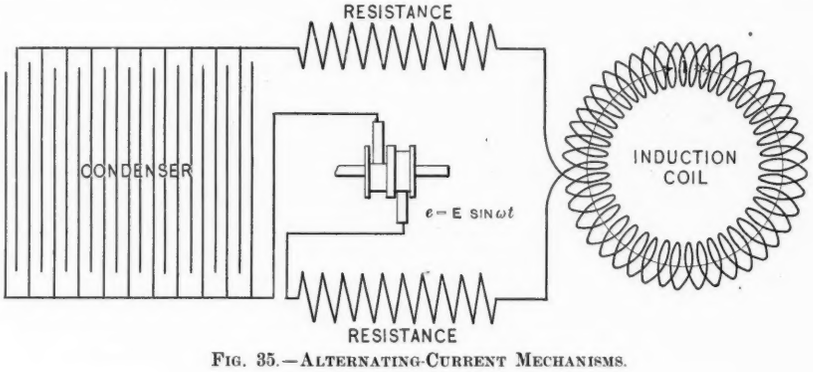


FIG. 35.—ALTERNATING-CURRENT MECHANISMS.

Early in last December the trustees of Newburg, Ohio, passed an ordinance revoking the franchise of the Chagrin Falls & Eastern Electric Railroad through that hamlet, as the company failed to fulfil the terms of its franchise in lighting a certain street. The defense of the company is that its failure to fulfil the agreement was due entirely to the tendency of the boys of Newburg to destroy the lights by throwing missiles, but the village authorities are determined that the company shall either live up to its agreement or not pass through their town.

THE JUNGFRAU POLYPHASE ELECTRIC RAILWAY.

SOME DETAILS OF THE ELECTRICAL EQUIPMENT OF ONE OF THE MOST REMARKABLE RAILWAYS IN THE WORLD.

One of the features of American electric railway engineering has been standardization of parts and systems, so that to-day nearly all installations for electric traction in the United States resemble one another in all matters of design and differ only in size and in minor details. It has been left to our colleagues on the other side of the Atlantic to take a bolder step and apply directly to moving electric trains the polyphase current, thus utilizing at its highest efficiency that variety of current most simply and easily generated in the dynamo machine.

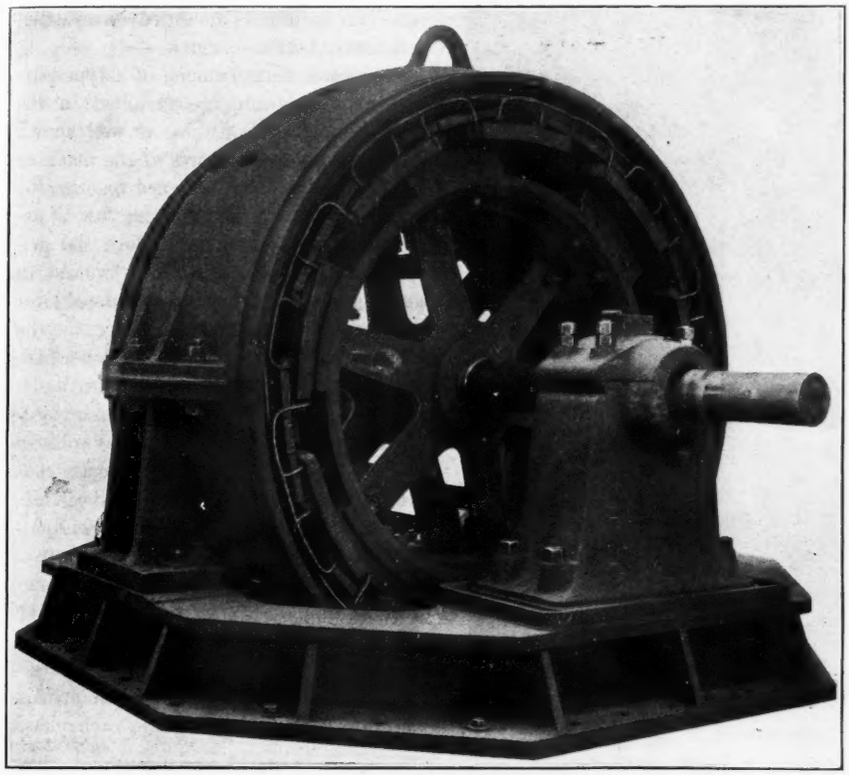


FIG. 1.—TYPE OF THREE-PHASE ALTERNATOR SUPPLYING CURRENT TO THE JUNGFRAU RAILWAY.

There have already been described in the ELECTRICAL REVIEW a number of the more important installations of this character, among them the long-distance, high-speed railway connecting Lecco and Chiavenna, in Italy, and the extraordinary inclined railway up and through the Jungfrau, in Switzerland.

This beautiful mountain has long been considered one of the most difficult summits for the Alpine climber, and the view from its summit has been regarded for a century as one of the most magnificent in Europe if not in the world. Still few have been able to endure the hardships required and the great exertion necessary to make the three-day trip to its summit on foot. For this reason it was deemed practicable by certain Swiss engineers and promoters to construct a railway to the summit of the mountain, it being well understood that vast numbers of the tourists who assemble in Switzerland each Summer would make the trip to the summit, if it were possible easily to do so in comfortable railway cars and without exertion. The mountain is very high and its sides are steep and swept by avalanches, so it at once seemed, when the scheme was considered from the engineering point of view, that it would be necessary to construct the railway to the summit in a tunnel through the greater part of its distance. It was decided, therefore, to build a tunnel with an average gradient of about one part in four and to operate trains in it by electricity, using a polyphase system.

Notwithstanding the well-known advantages of electric motors using this variety of current, the majority of railway engineers have adhered closely to the development of direct-current traction systems, modeled upon those which have proven themselves successful after years of experiment and experience in street-tramway service. It is, therefore, a considerable departure to undertake the operation of an electric railway by motors using alternating currents directly, yet the promise of such a system in efficiency, in operative ease and in simplicity is certainly sufficient to make the experiment that is now in process of being tried in the Swiss mountains, one well worthy the attention of electrical and railway engineers the world over.

Power for the operation of the line will be derived from two generating stations, both operated by water-power. A total capacity of about 5,000 horse-power will be installed in them. The first of the two stations to be erected is at the village of Lauterbrunnen, this plant being now in partial operation. It will supply about 2,000 horse-power, while the other station erected near Grindelwald will supply the balance. The water comes to the present

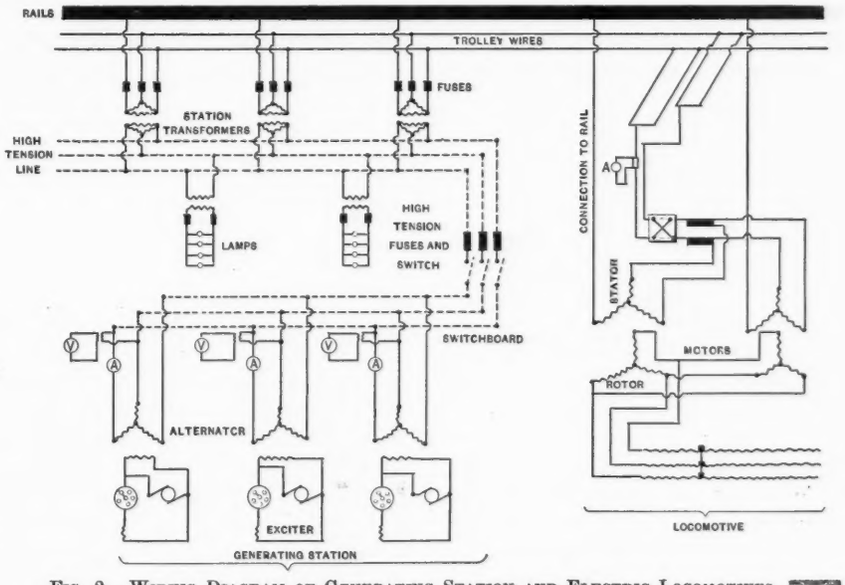


FIG. 2.—WIRING DIAGRAM OF GENERATING STATION AND ELECTRIC LOCOMOTIVES, JUNGFRAU RAILWAY.

installation from a mountain torrent, known as the Weisser Lütschine, through a steel pipe about six feet in diameter and nearly half a mile long. The upper part of the tube is built of steel plate in sections 20 feet long, using material a little less than one-quarter inch thick. The lower portion is made in 25-foot lengths, using three-eighths-inch steel plates closely riveted. The head at the turbines is about 125 feet. In all there are six wheels of the Gerard type, made by Messrs. J. J. Rieter & Company, of Zurich, three of the wheels giving 500 horse-power each, one giving 800 horse-power, and the others being small wheels for the operation of the exciters.

Fig. 3.—A Difficult Bit of Feeder Line Construction, Jungfrau Railway.

To the main power-wheels are directly coupled alternators of a three-phase type, made by the Maschinenfabrik Oerlikon, of Oerlikon, near Zurich, in Switzerland. The machine is illustrated in Fig. 1. It is of an inductor type, giving 7,000 volts in each phase at 380 revolutions per minute under a frequency of 38 periods per second. The machines have stationary field coils and stationary armatures. Two exciters are provided, each absorbing about 25 horse-power and giving direct current at 120 volts for the excitation of the fields.

The arrangements of the generators, transformers, substations, trolley wires and motors on the locomotives are well shown in Fig. 2. In Fig. 3 is shown an indication of the difficulty encountered in passing the high-tension, three-phase feeding line over some of the mountain slopes required to reach the numerous substations scattered along the work. Fig. 4 exhibits the back of one of the switchboards in the generating station, showing the method of supporting all of the high-tension current-carrying parts on heavy porcelain insulators mounted on a structural steel frame.

Step-down transformers, of a type particularly European, are installed in the substations. One of these is well shown in Fig. 5. The iron cores of the machine are three in number, fastened together by yokes at the top and bottom, as is exhibited in the engraving. Both the primary and secondary coils are wound in sections as shown, and are arranged over the cores and fastened in place by the broad yoke when this is screwed down fast.

Numerous substations are distributed along the line for reducing the main feeder pressure of 7,000 volts to 550 volts in each phase of the three-phase delta-connected trolley system. As has been described before in these pages, the conducting system consists of two trolley wires, fed appropriately from the transformer stations, and the track, these forming the three sides of a three-phase system. In the substation in the town of Lauterbrunnen there are other transformers working down to 120 volts in each phase

Fig. 4.—The Back of One of the Switchboards in the Generating Station, Jungfrau Railway.

and used for operating a synchronous motor direct-coupled with a continuous-current generator used for charging storage batteries. These batteries are used for lighting purposes, working back through the generator as a motor and the synchronous motor as a generator to supply current to the main line for lighting purposes when the main dynamos in the stations are at rest.

The total length of the transmission line from the generating station at Lauterbrunnen to the top of the mountain is about 20 miles. In this distance a drop of 10 per cent or 700 volts is allowed. Three copper conductors of about eight millimetres (five-sixteenths inch) diameter are used on the main transmission line, the insulators being of the triple-petticoat porcelain style. From the generating station to the first substation, located at Scheidegg, is about four miles horizontally and a little over one mile vertically. This substation, like the others along the line, is supplied with two transformers of 200-kilowatt capacity each, reducing the current to a pressure of 550 volts for direct feeding to the trolley line. In all there will be 12 substations along the entire line, the highest one being about 13,000 feet above sea level, and the distance apart of the substations averaging about one and a half miles.

The lower part of the railway runs

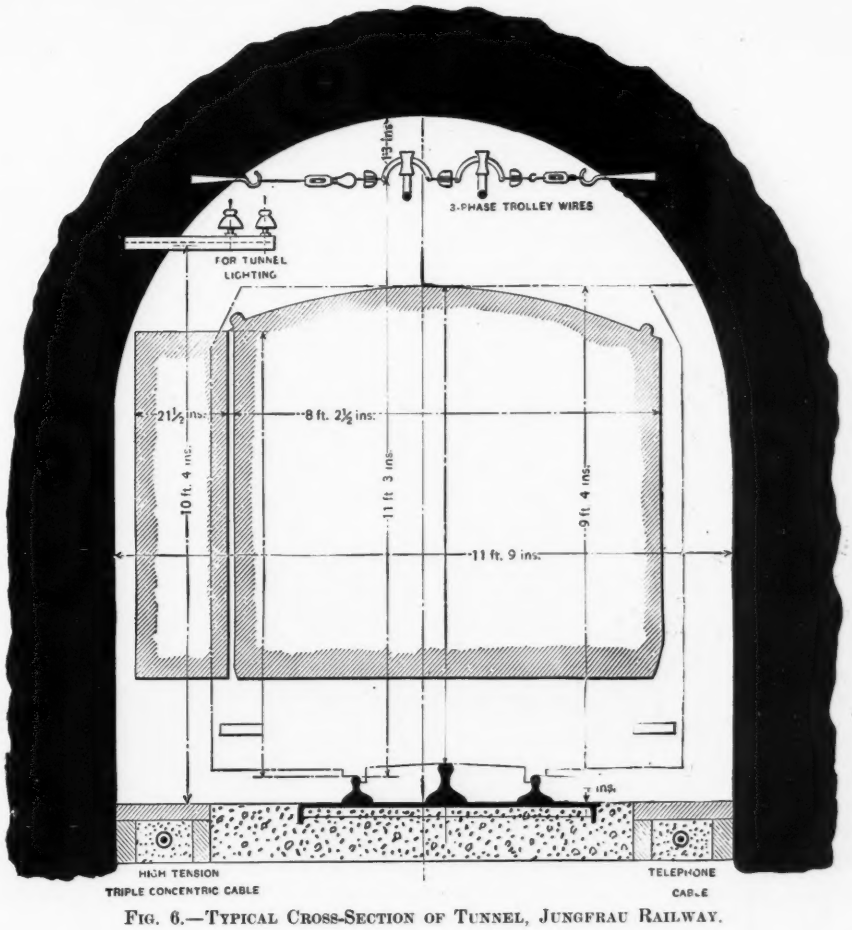


FIG. 6.—TYPICAL CROSS-SECTION OF TUNNEL, JUNGFRAU RAILWAY.

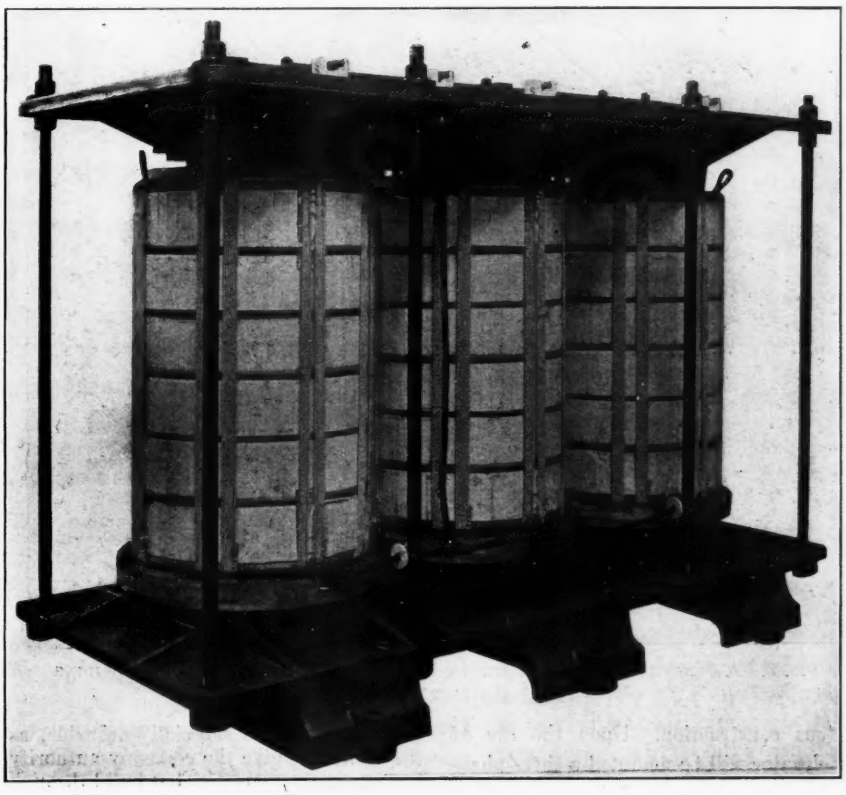


FIG. 5.—ONE OF THE STEP-DOWN SUBSTATION TRANSFORMERS, JUNGFRAU RAILWAY.

along in the open, and at a point about half-way up the mountain enters the tunnel, in which it remains until it reaches a point immediately below the summit of the Jungfrau. The tunnels are about seven miles in length and will have cost, when completed, about $1,000,000. In Fig. 6 is shown a cross-section of the tunnel exhibiting the overhead trolley wires, high-tension, triple-concentric cables used for the high-tension feeding and telephone cables on the other side of the track

At present a transformer station of 400-kilowatt capacity has been installed near the entrance of the tunnel, supplying low-tension, three-phase currents for operating rotary and percussion drills working on the rock at the heading. All of the stations along the line are lighted and heated by electricity and the explosives used are warmed also by electric ovens before they are used on the work. Curiously enough, in this work explosive gelatine is used as a blasting compound and this substance, unlike dynamite, is safer when warm than when frozen. Consequently it is kept, at the high stations where the temperature is normally low, in boxes warmed by electric heaters so as to prevent its freezing and becoming dangerously explosive.

Throughout the length of the tunnel, arrangement for lighting has been made by bridging incandescent lamps across the low-tension feeder circuits about 80 feet apart.

The locomotives used on the line are shown in the accompanying illustrations

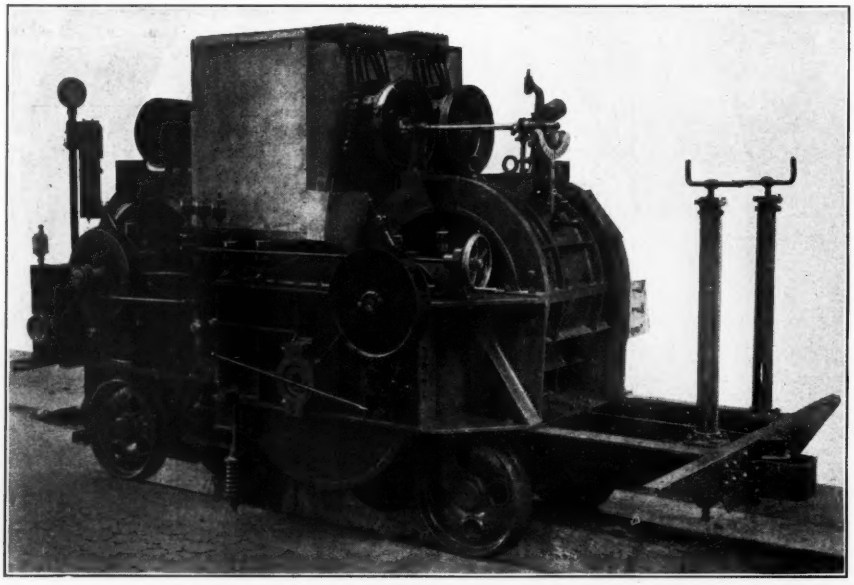


FIG. 7.—A VIEW SHOWING DETAILS OF THE ELECTRIC LOCOMOTIVE USED ON THE JUNGFRAU RAILWAY.

in various stages of completion. The machines were built by Messrs. Brown, Boveri & Company, of Winterthur, Switzerland, and the Oerlikon Company. Upon each is mounted two motors of 150 horse-power each, the normal speed of the motors being 760 revolutions per minute. The motors are connected, as the illustrations plainly show, by a double-reduction gearing with both the running wheels on the track and with sprocket wheels engaging in a continuous rack laid between the running rails for the length of the road. Control is secured by means of resistances cut in and out of the rotor circuits of the motors by means of a controller. Upon each locomotive is mounted a three-phase induction motor of about one-kilowatt capacity driving a ventilating fan which forces air through the resistances in order to keep them cool.

The later type of locomotives are equipped with two 220-horse-power induction motors, each having a normal speed of 500 revolutions per minute. The pinions mounted upon the driving axles are of aluminum bronze and brake wheels and blocks are also provided upon these axles, acting directly upon the heavy pinions meshing with the rack-work.

Current is taken from the trolley wires by means of sliding contacts or shoes instead of wheels. It is estimated that the maximum speed attained will be from eight to nine miles per hour with loaded trains. Passengers arriving at the station, excavated from the rock of the mountain immediately under its summit, will be transported to the top, some 300 feet higher, by means of an electric elevator of

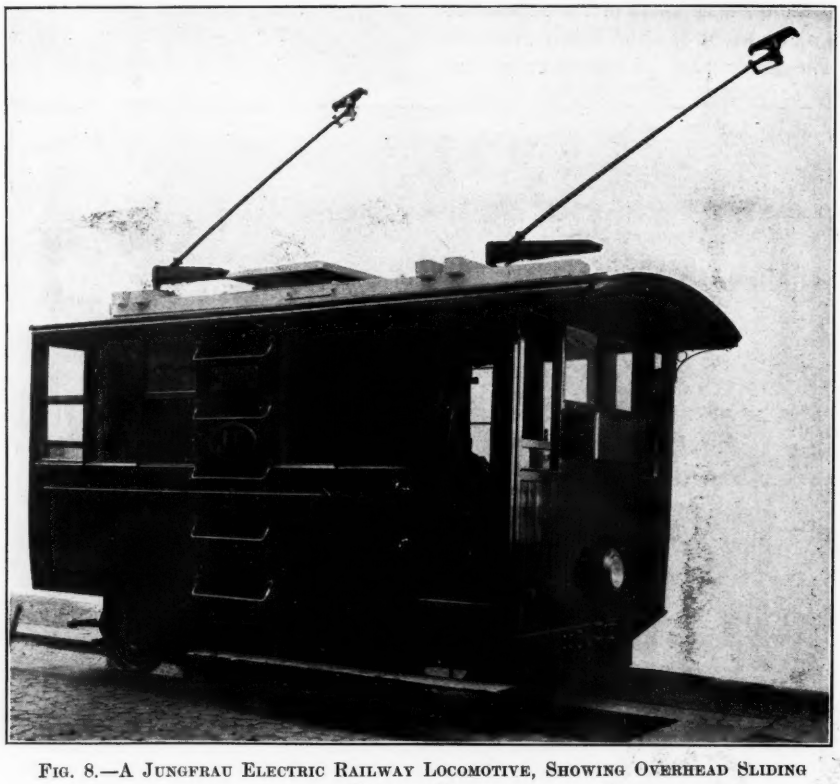


FIG. 8.—A JUNGFRAU ELECTRIC RAILWAY LOCOMOTIVE, SHOWING OVERHEAD SLIDING CONTACT SHOES.

curious construction. Upon the car of the elevator will be mounted a three-phase motor moving toothed pinions working in racks on the sides of the shaft.

The boldness of engineering design shown in the construction of the Jungfrau railway has attracted to the work the attention of engineers in all parts of the world. The progress of the work upon it will be carefully watched and it is trusted that its success, which seems likely, may prove a sufficient reason for the equipment of many other long and difficult lines with electric traction apparatus using polyphase current directly upon the moving machinery.

A Westinghouse Dividend.

The Westinghouse Electric and Manufacturing Company has declared a regular quarterly dividend of one and one-half per cent on the assenting stock, payable February 15. The books will close February 5 and reopen February 21.

Tucker, Anthony & Company, of Boston, are at the head of a syndicate which will build a 40-mile electric road between Columbus and Newark, Ohio. The company will be known as the Columbus, Buckeye Lake & Newark Traction Company. The company is already incorporated and has its franchises. About 15 miles of grading has already been accomplished. It will have $1,250,000 five per cent bonds and $1,250,000 stock. The road will serve a population of about 250,000 people. Its franchises are especially valuable, as they not only give the company authority to connect the two cities but build through the principal streets of both Columbus and Newark.

The Poulsen Telegraphone in the United States.

One of the most notable pieces of apparatus exhibited at the Paris Exposition last Summer, and one that perhaps attracted more attention than any other shown in the electrical section, was the extraordinary form of phonograph invented by Mr. Valdemar Poulsen, a Danish engineer. It will be remembered by readers of the ELECTRICAL REVIEW that the instrument was fully described in the issue of this journal for June 20, 1900.

The telegraphone consists of a steel wire which is generally, for the sake of convenience, wound on a brass cylinder in a rather close spiral, and a very small electromagnet, or pair of electromagnets, the poles of which embrace the wire closely. The arrangement of the apparatus is

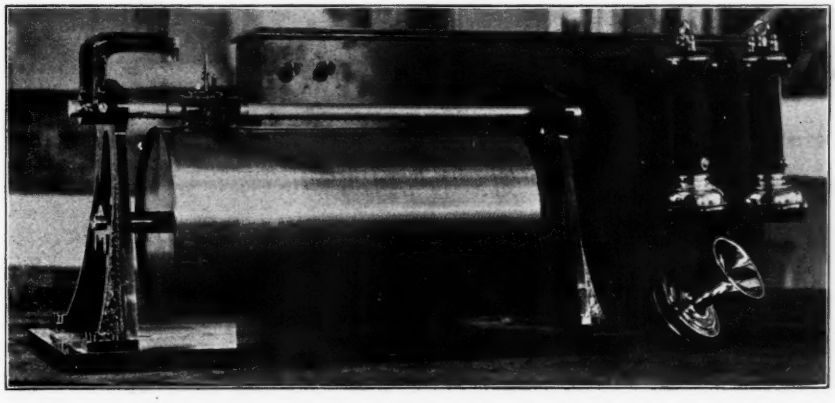


FIG. 1.—THE POULSEN TELEGRAPHONE, CYLINDER TYPE.

such that the wire may be drawn between the poles of the magnet at a considerable speed by the rotation of the cylinder, or in other forms of the apparatus by unreeling it from one reel and spooling it on another. When a telephone transmitter is connected in circuit with the small electromagnet and speech or other sound is made before it, it is easy to see that there is a fluctuating field of magnetic force set up between the poles of the small electromagnet and in a direction transverse to the axis of the moving steel wire between them. This causes a certain magnetization of the wire, which is supposed to be homogeneous as regards its magnetic condition when it is passed through the apparatus. The magnetic fluctuations following the current waves in the telephone circuit impress themselves upon the wire as disturbances of its magnetic condition exactly corresponding in intensity and direction to the fluctuations causing them. If, now, a telephone receiver is connected in place of the transmitter and the wire is again run through between the poles of the small electromagnet the latter becomes virtually a form of dynamo machine, and currents are generated in the coils surrounding its cores in exact accordance with the fluctuations of magnetization in the wire passing between its poles. In this way there is reproduced in the telephone circuit current waves identical with those that originally caused the magnetization of the wire, and hence the instrument becomes a singularly perfect form of phonograph.

How perfect it is one can only know by hearing its reproduction of the voice. There is an entire absence of the scratching and buzzing sounds from which no form of mechanical phonograph is entirely free. The reproduction of speech is clear and exceedingly distinct, the sound greatly resembling that of conversation over a good telephone line. The most notable feature of the reproduced sound is the apparently entire absence of all extraneous sounds whatsoever.

The wire may be restored to its original condition by magnetizing it in one direction in a strong constant field. This is accomplished by running the wire between the poles of the small magnet when the latter is permeated by considerable direct current. It is stated that a record on such a wire has been reproduced 2,200 times without losing its force or character. The "cleaning" of the wire of its record by means of the steady magnetization is very perfect, no trace of sound being heard on wire thus treated. It is stated, however, that in the case of a cylinder which had become rusted through exposure to the air, the wire was vigorously cleaned by means of sand-paper and oil, it being thought that this might remove the record as well as the rust, but the record remained practically intact after this treatment.

A number of the instruments in their various forms have recently been brought to this country by some gentlemen of the Danish company and have been exhibited by them to the engineering representatives of large operating telephone companies and other people interested in this class of work in the United States. It is understood that negotiations are now pending for the American rights to the instrument.

The accompanying illustrations give an excellent idea of the types of instrument now in the United States. Fig. 1 shows a cylinder form of telegraphone, the cylinder being covered with a spiral of fine steel piano wire upon which, in a frame, runs the small electromagnet shown in actual size in Fig. 2. This is used both for making the record, for reproducing it and for cleaning the wire of its magnetic strains. The box in the background contains a battery and small motor for operating the cylinder. Another ingenious and interesting form of the instrument is

FIG. 2.—TELEGRAPHONE ELECTROMAGNET—ACTUAL SIZE.

shown in diagram in Fig. 3. In this instrument a continuous wire or steel tape is used running over two drums, and at E is placed a record-making

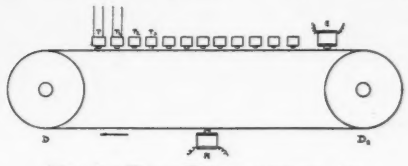


FIG. 3.—BAND TELEGRAPHONE FOR DISTRIBUTING MESSAGES.

electromagnet. A large number of other electromagnets reproduce this record one after the other in telephone circuits appropriately connected to them, so that the instrument becomes available for the reproduction of a single message in a large number of circuits and is useful for sending out stock quotations and such other matter as must be duplicated to a large number of subscribers. The tape after passing these magnets is cleared of its record by the magnet R, which is permeated by direct current.

In the larger instruments, using a long tape or wire reeled on drums, the capacity of the machine is sufficient for about one hour's continuous operation. The smaller cylinder machines as now made are suitable for records of about two minutes in length. The gentlemen who are here in charge of the apparatus express the belief, which may readily be granted, that what the instrument has accomplished so far is merely an indication of what its future perfection may bring forth. It is available either as a phonograph or as a means of recording telephone conversations and reproducing them at will, as a distributor for telephone announcements or signals, and in a variety of other ways which will readily suggest themselves to any one examining it.

A NEW PAGE-PRINTING TELEGRAPH—I.*

BY WILLIAM B. VANSIZE.

The problem of automatically recording telegraph messages in Roman type is one that has fascinated inventors almost from the days of Morse. Royal E. House invented a type printing telegraph, which was in successful operation in this country in competition with the Morse and Bain systems prior to 1857. Many years ago the stock ticker was perfected, and the Hughes, a tape printing telegraph, and several modifications of it have been employed for a long time with success by various telegraph administrations, chiefly on the Continent of Europe. But it is only within the last year or two, almost at the close of the nineteenth century, that the problem of constructing a long-distance, high-speed, page-printing telegraph has been solved. A printing telegraph of this kind has recently come to my attention.

It has received the commendation of practical men in the telegraph service, and is believed to be of such simplicity and merit as to win for itself and maintain a position among the apparatus and instruments in constant use on commercial telegraph lines. The arrangement referred to has been devised and constructed by and under the direction of Donald Murray, an Australian journalist, without prior practical experience in telegraph work.

A RETROSPECT.

Looking back over the last 30 years, a substantial part of which time has been spent in the service of the large telegraph corporations, I can recall but comparatively few arrangements of apparatus which have passed the experimental stage and gone into commercial use. In 1869 there was the well-known Morse key and spaced alphabet, with the relay and sounder, and in some few instances the embossing register at way stations. In 1872 or 1873, circuits were equipped with balanced receiving apparatus and continuity preserving transmitters for duplex transmission. A little later, reversals of current were used for one set of signals, and variations in current strength for another set of signals, affording two transmissions in the same direction. By duplexing the last-named arrangement the quadruplex was brought to a more or less satisfactory condition through the efforts of Edison, Nicholson, Prescott, Gerrit Smith and others. About 1875 there was introduced on the lines of the Atlantic and Pacific Telegraph Company an automatic system of transmission improved by Little and Edison, employing a perforated paper strip at the transmitting station, and a chemically-prepared paper strip to record the Morse characters at the receiving station. Some years later the Wheatstone system was first employed by the Western Union Telegraph Company. Later Mr. Delany's arrangement for distributing a single main line between a number of sending and receiving operators at separated stations was employed on a special line between Boston and Providence. Numerous systems of printing telegraphs, recording upon a strip of paper and upon a page, have been patented and exploited by corporations organized for that purpose.

The Phelps motor printer, in this country, and the Hughes printing telegraph upon the Continent of Europe, both recording upon a strip, have had more or less extensive employment.

It is undoubtedly objectionable to use a perforated strip for transmitting purposes; but when to this is added a received record to be translated, there exist objections which only other merits, as in the case of the Wheatstone apparatus, partially compensate. At the other extreme is the simple Morse requiring no added time interval for translation at either end of the circuit; the operation of transmitting and recording being substantially co-extensive with the time in transit.

RECENT DEVELOPMENTS.

The later improvements in printing telegraphs have been directed to finding a substitute for the direct manual operation of the keyboard and the employment of automatic transmission like that of the Wheatstone system, by the use of perforated tape. The work of the operators in transmitting messages is thus first stored in the perforated tape, produced at any convenient speed, and the automatic transmission may take place at a high and uniform rate, the line and receiving instruments being worked to their full capacity. Another means for overcoming the delay due to direct manual transmission is to divide up the use of the line among several operators, a locking device holding the line for an interval at the service of each in turn. In this case while the speed of the operator may be slow, the total use of the line and instruments is greater than one operator could achieve working at his highest rate. There are two arrangements of apparatus now receiving attention employing the transmitting tape; that of Charles L. Buckingham, and that of Donald Murray, the latter here under consideration. The French system of Emile Baudot and the American system of Professor Rowland employ an arrangement for dividing the use of the line among several operators.

What telegraph officials really need is the simplicity of the Morse system combined with increased speed of transmission and economy of time between the transmitting customer and his addressed correspondent. Up to the present time nothing has surpassed the Morse for this purpose. We may economize time on the wire by the Wheatstone, by the chemical automatic system referred to, or by the use of Delany's multiplex system; we can provide for a special class of telegraph business by adopting some of the high-speed transmitting systems like those contemplated by Professor Crehore, or by Delany's modification of the chemical automatic. For these high-speed systems requiring preparation for transmission at one end and translation for delivery at the other end, a demand must be created by the requirements of a class of business to be transmitted and delivered faster than the mail, and somewhat slower than the transit time of the Morse system.

In the recent development of Morse there is an analogy between the contest between the armor and armor-piercing projectiles on the one hand and the transmitter and receiver of the Morse code on the other. In the case of armored vessels an increase in the thickness or resistance of the armor has been answered by increased capacity for penetration by the projectile, and *vice versa*. In the early days the embossing or recording register could easily record the most rapid Morse sender. When receiving by sound it is an effort to keep up with the speed of a rapid sender, where the receiver uses pen to record in script. When the typewriter is substituted for the pen, the receiver can more than keep pace with the sender; if we introduce automatic Morse transmission we surpass the power of the human ear to receive and translate to the typewriter. If we transmit mechanically and record mechanically by means of a typewriter we shall have eliminated these human agencies with their limitations, and that is what Mr. Murray has done in a very complete and satisfactory manner.

Before further considering Murray's arrangement, I want to assign due credit to my friend, Chas. L. Buckingham, who has a marvelously ingenious system in commercial use on the lines of the Western Union Telegraph Company. The received record is made in print on the ordinary telegraph blank; the transmission is by means of a perforated paper strip. It has a maximum capacity of about 100 words a minute on a circuit between New York and Chicago. The circuit can be duplexed to double the stated capacity. Its use, I believe, is successful, and commercially so.

MURRAY'S SYSTEM — TRANSMITTING ARRANGEMENT.

Mr. Murray employs a special alphabet, perforating the transmitting tape with a keyboard perforator, having a separate movable lever for each character; each character occupies an unvarying linear space on the tape, and consists of five perforated and unperforated subdivisions of such space. The difference in the number and succession of these subdivisions or perforations imparts the designating characteristics. There are no spaces between successive letters or characters. Either makes and breaks, or reversals can be used in transmitting. It is to this fundamental fact—all letters of the same length—that the success of the system is due. Each letter occupies half an inch on the transmitting tape, and a similar length on the receiving tape. The result is that a comparatively simple transmitting tape perforator worked by an ordinary typewriter keyboard is rendered possible; there is no necessity for employing a complicated differential paper feed mechanism to provide for letters of vary-

* A paper presented before the American Institute of Electrical Engineers, January 25, 1901.

ing length. In connection with the ordinary typewriter keyboard there is a group of ten punches, one punching magnet, and one spacing magnet, controlling a motor-driven escapement.

THE RECEIVING APPARATUS.

At the receiving station there is an electromagnet perforating device which accurately reproduces the transmitting tape by producing corresponding perforations and spaces. This received perforated tape passes from the receiving perforator into the typewriter operating device. This typewriter operating device consists of five longitudinally reciprocating bars or "combs," 39, Fig. 1, presenting five pointed terminals, 40, to a perforated plate or die, 38. The perforated tape passes between the surface of the perforated plate and the pointed terminals of the bars. The pointed terminals of these bars register respectively with the five holes in the die. The tape is moved along between the die and the pointed ends of the bars step by step, the length of a letter or character at each step, say one-half inch. When perforations in the tape coincide with the pointed ends of the bars, and corresponding perforations in the plate and die, and the plate is moved toward the pointed ends of the bars, the bars are or may be separated into two groups; one group is moved longitudinally, corresponding with the unperforated subdivisions of the tape, the other group project through the perforations in the tape and in the die, and are unmoved. Lying over the five bars or "combs" at right angles thereto, are a series of thin metal strips, 41; each strip is mechanically connected with its individual key lever on the typewriter. The upper surfaces of the five bars first described are notched arbitrarily. These notches are caused to be aligned below any one of the strips under the control of the perforated tape and die; when any one of the strips drops into a groove a motor-driven cam engages it and produces a movement of the typewriter lever. The movement of the die and paper tape and of the typewriter key-lever is produced by motor-driven cams. It will be seen that this mechanism will operate not only a typewriter, but any keyboard machine such as a typesetting machine or linotype. The perfected receiving tape is therefore available for setting type automatically.

THE GENERAL DIAGRAM.

In the general diagram (Fig. 1) shown, there is the apparatus at the transmitting station, connected by a single main line, 9, with the apparatus at the receiving station. I have placed a double marginal line around the apparatus at the transmitting station to distinguish it. The vibrating reed, 1, is in a local circuit with an electromagnetic motor, 2. The reed makes and breaks its own circuit, and is substantially like the well-known La Cour phonic wheel device. The "prickers," 4 and 5, familiar features in the Wheatstone transmitter, are located as usual in line with the advancing lines of perforations in the transmitting tape, 3; 6 and 7 are reciprocating rods engaging respectively with opposite terminals of the centrally-pivoted, pole-changing switch arm, 8. The parts shown are all essential parts of the well-known Wheatstone transmitter, which is here used practically without alteration, except that the prickers, 4 and 5, are arranged to move or reciprocate together instead of alternately, thereby enabling any described multiple of a single impulse to be transmitted. The ordinary arrangement of the Wheatstone transmitter can only transmit unit signals or odd number multiples thereof; it is practically an alternating-current generator. The Wheatstone signals have to be built up by omitting a positive or negative impulse, hence an ordinary Wheatstone transmitter can transmit a dot or a dash equal to three or five dots, but can not transmit a dash equal to two or four dots. Mr. Murray, to avoid this difficulty, arranges the prickers to reciprocate together instead of alternately. There is thus obtainable transmitted impulses or dashes equal to one, two, three, four, or five dots, with corresponding spaces.

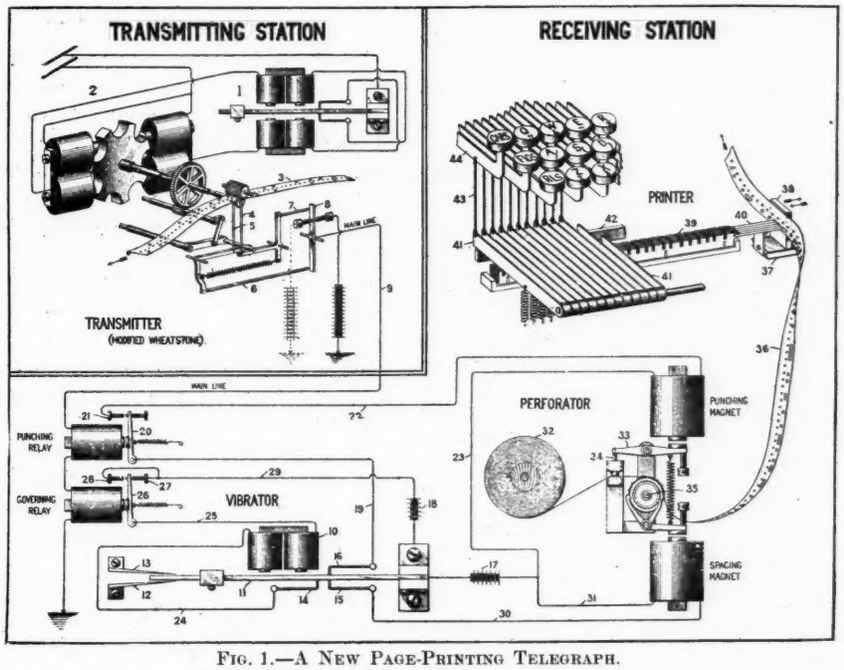


FIG. 1.—A NEW PAGE-PRINTING TELEGRAPH.

In transmitting, the number of impulses thrown upon the main line is minimized by producing the impulses locally at the receiving station, and employing only sufficient main line impulses to determine the action of the perforator. At the receiving station there is, therefore, a main-line relay to determine the action of the punching magnet, and a governing relay which operates to maintain unison between the main line impulses as they arrive and corresponding impulses in the local circuit. For the purpose of creating these local uniform impulses there is a vibrating reed, 11, operated by an electromagnet, 10. The circuit of this magnet extends from the local battery, 18, through the reed, 11, contact point, 14, wire, 24, magnet, 10, wire, 25, armature, 26, of the governing relay, thence by way of the points, 27 or 28, and wire, 29, to the battery. The precise operation of the governing relay I will describe presently. The receiving perforator is composed of a punching magnet and a spacing magnet; the punching magnet operates a spring-retracted, pivoted armature bar, 33, mechanically connected with the punch, 34, reciprocating through a guide-block and engaging the tape, 32, upon the surface of a suitable die, over which the tape passes. The tape is fed along by a star wheel located on a motor-driven shaft, 35, and upon this shaft is an anchor escapement under control of the spacing magnet. The vibrating reed, 11, alternately makes and breaks the local circuit of the spacing magnet; this circuit extends from battery, 17, to the reed, 11, contact spring, 15, wire, 30, through the magnet and wire, 31, to the battery. The punching magnet is in a local circuit with a break-point operated by the vibrating reed, 11, and controlled by break points of the punching relay, so that while the reed is continually generating local circuit impulses, these impulses are effective to operate the punching magnet at such times only as the punching relay is closed upon its front contact. This local circuit passes from the battery, 17, through reed, 11, to contact point, 16, thence by wire, 19, armature bar, 20, contact, 21, wire, 22, through the punching magnet, and wire, 23, to the battery. It will thus be seen that the reed 11, is continually making and breaking two circuits alternately; first, that of the spacing magnet, which is a continuous operation; and second, that of the punching magnet, which is an intermittent operation, rendered so by the action of the punching relay. This punching relay and also the governing relay may be either neutral relays responsive to makes and breaks, or they may be polarized relays responsive to reversals of current. As the reed, 11, vibrates, the electric impulses in the spacing magnet circuit per-

mit a steady progressive movement of the tape, 36. Upon the arrival of an impulse of current from the transmitting station, the contact points, 20 and 21, of the punching relay are held closed for one, two, three, four, or five times the time interval of one dot length, and while this relay circuit-breaker is closed, the punch, 34, operates to perforate the tape as many times successively as permitted by the time-length or duration of the transmitted impulse upon the main line. Mr. Murray has thus avoided the necessity of transmitting over the main line all impulses necessary to produce spacing, and all but a fractional part of the impulses necessary to produce the perforations. It is of vital importance, however, to preserve unison between the arriving transmitted impulses in the main line and the local punching and spacing impulses at the receiving station. This is done in the following manner:

HOW UNISON IS MAINTAINED.

The governing relay operates a circuit-breaker, 26, moving between two fixed contacts, 27 and 28, electrically connected to the same circuit terminal, so that the moving contact in going from one to the other operates to open the circuit during its time of transit only. I have referred to this briefly as "armature transit time." This break in the local vibrator circuit takes place at the beginning and end of each main-line signal, and as the main-line signals arrive at a uniform rate and are of unit or multiple unit duration, the governing relay operates its break-point at uniform unit intervals or multiples of these intervals. In the same circuit in which this break-point operates, there is also the break-point, 14, of the motor-magnet, 10, which works on the familiar buzzer principle. There are thus two break-points in the same circuit. If they open and close together, then full vibratory impulses flow through the motor magnet. If, on the other hand, the rate of vibration of the reeds tends to accelerate, or the rate of the arriving current signals tends to lag, then the two breaks occur more or less alternately and consequently less current gets through—the impulses are clipped—and the rate of vibration of the reed is reduced. In practice the receiving vibrator is set to go one or two per cent faster than the rate of the arriving signals, and then the governing action of the two interfering break-points in the same circuit results in the establishment of a steady dynamic balance between the accelerating tendency of the reed and the retarding tendency of the arriving main line signals. By this arrangement the necessity for sending correcting impulses over the main line to secure synchronism is avoided, the correcting impulses being obtained locally with the cooperation of the main-line signals themselves.

It is to be understood that movable weights are present upon each reed, that of the transmitting station and that of the receiving station, and by varying the position of the weight upon the reed the rate of vibration and the rate of transmission may be changed. At the receiving station there is provided means whereby the rate of vibration of the reed may be varied in harmony with variations in current in its motor-magnet circuit. Under normal conditions with a motor-magnet and circuit operated by break-points carried by the reed, an increase of current, resulting in increased magnetic effort, will decrease the rate of vibration, and, conversely, a decrease of current resulting in decreased magnetic effort will accelerate the rate of vibration. This is believed to be due to eddy-currents generated by the magnetic field of force and the movement of the reed in such field. The action described, while it has a damping effect, is of no practical use as a means of regulation for the work to which the reed is here put, because of its exceedingly limited range. It is necessary in maintaining unison to have a considerable range of variation in the speed of this reed, such variation in speed to be attained in response to variation in the length of current impulses of uniform strength.

CONSTRAINED VIBRATION OF THE REED.

To secure this result there is placed at or near the free end and upon the opposite sides of the reed, resilient stops, shown at 12 and 13. These springs receive the reed on each side with a cushioning effect and impart an initial return movement. In explanation of this result it is to be recalled that the rate of vibration of a reed varies with its length, mass, and the distribution of such mass; increase of current in the motor-magnet circuit increases the amplitude of vibration without varying the speed beyond the slight electromagnetic damping effect already described. The energy imparted to the reed by the motor magnet is dissipated by the air resistance and molecular friction in the reed; an increase in the propelling energy brings a corresponding increase in the dissipation noted. Therefore, while the amplitude of vibration is widened, the speed is not increased. If fixed limiting stops be provided, to limit the amplitude of vibration, the energy of the reed can not then be dissipated in the manner first described to the same extent, and there results an increase in the rate of vibration, while a portion of the energy imparted to the reed is dissipated in heat generated at the point of impact. To avoid this loss and further increase the rate of vibration, the energy which would otherwise be lost at a rigid contact is stored in the resilient devices, 12 and 13, already referred to, to cushion the impact of the reed, and impart an initial return movement. By this expedient, the movement of the reed is rendered smooth and uniform; it is freed from the interference due to the impact with a rigid stop, which acts to jar and disturb the normal rate of vibration, and its rate may be varied by varying the current impulses.

In further explanation of this device we may recall the fact that, within the limits of elasticity, a helical spring varies in length in arithmetical ratio with the force extending it; that is to say, if a helical spring extends one inch with a weight of one pound, it will extend two inches with a weight of two pounds, and so on. Within restricted limits the same rule holds good with simple flat springs of uniform thickness, like those commonly employed for electrical contact purposes. It has been found by experiment that springs of this kind, whether arranged for tension or for compression, do not vary the rate of vibration of the motor-driven reed to any appreciable extent in response to variations of current in the motor-magnet circuit; but if resilient stops are constructed and arranged, like 12 and 13, to rapidly compound their resistance to the impact of the reed, they are practically operative for the purpose of varying the rate of vibration in response to variation in current.

The Ganz Traction System.

It was noted in the ELECTRICAL REVIEW lately (January 19) that the lowest bid received for the equipment of the old Metropolitan District underground railway, in London, was from Messrs. Ganz & Company, of Budapest. The subjoined note from a British contemporary refers to this system:

"Sir William Preece and Mr. T. Parker have started for Budapest in order to report on the electric traction system which has been developed by the firm of Ganz & Company, of that town. The object of the visit is to make a report to come before the directors of the Metropolitan District railway. The Ganz system of electric traction was referred to at the recent discussion on electric locomotives for main-line traffic, read by Mr. W. Langdon before the Institution of Electrical Engineers. In it three-phase currents are employed at high voltage, no less than 3,000 volts being used on the overhead wires above the track. The novelty in the system is the employment of two motors in series when starting up. The first motor has its field connected with the collectors from the line wires. The rotor of this motor is connected to the field of the second motor, whose rotor can be regulated in the usual way. In consequence of this, much greater power can be attained when starting, as the frequency of each unit of the combination is half that of the supply. In the same way when it is desired to stop the train by reversing connections, energy can be restored to the line until the speed has dropped to half of the maximum. We presume that the above engineers will inspect the experimental line which Messrs. Ganz & Company have established in Budapest. This has given such satisfaction that considerable lengths of railway in Italy are being converted for electric traction."

Science Brevities

Spectra of Radium and Polonium—By means of Runge's method of fusing the salt into a platinum coil and then using it as an anode for a spark-gap, Herr G. Berndt has discovered no less than 15 lines of the polonium spectrum. An *Electrician* abstract says: This is all the more interesting as no measurements of the lines due to polonium had yet been made. The two strongest lines in the photographic spectrum have a wave-length of 3,361.5 and 3,349.2 Angstrom units respectively, with a maximum error of 1.5 units. Active bismuth nitrate of intensity 300 was used for the measurements. For extending the known spectrum of radium, the author used active barium chloride and bromide. Salts of the intensity 240 only gave the radium line at 3,814.59. But a salt of activity 1,000, prepared in Paris, gave, in addition, the lines 4,682.346, 3,814.591 and a new line, 2,708.6. Down to wave length = 2,100 no further radium lines were found. The spark was in all cases furnished by two Leyden jars charged by a large induction coil, and the platinum coil was kept in a state of incandescence. Under these circumstances, the space between the electrodes was filled with the vapor of the salt, and the platinum and air lines were quite faint.

Pressure and Temperature in the Electric Spark—Herr E. Haschek has supplemented his own and Mache's experimental work on the pressure and temperature within the electric spark by a theoretical treatment based upon the conceptions of Schuster. According to an *Electrician* abstract, it is supposed that at the beginning of the discharge certain minute particles, whether of air or of electrode material, are projected with a great velocity from both electrodes. Their initial velocity between zinc poles would be about 3,000 metres per second, but owing to the resistance of the gas traversed, this velocity would fall to about 400 metres per second by the time the particles are four millimetres away from the electrodes. The collisions which bring about this retardation also produce a rise of temperature, and the retardation itself produces an accumulation of particles which gives rise to an increase of pressure. Both pressure and temperature show a strictly corresponding distribution. With five large Leyden jars and a spark-gap of 8 millimetres the maximum temperature would be some 1,000 degrees in the centre, and the maximum pressure would amount to some 28 atmospheres. This is of the same order as the pressure determined experimentally.

The Auroral Spectrum—On the Danish expedition into Iceland, the spectrum of the aurora borealis was photographed, and compared with the spectrum of the brush discharge from a metallic wire, but especially with the photographic spectrum of the light around the negative electrode of a discharge tube containing oxygen, a Scheiner spectrograph being employed. The auroral spectrum has a "principal ray" of wave-length about 556 tenth-metres, two strong bands at 428 and 392 tenth-metres, and numerous weaker bands extending into the violet as far as 337 tenth-metres. The spectrum of the brush-discharge contained all of these bands save those at 428 tenth-metres and 392 tenth-metres; the cathode discharge in oxygen reproduced quite closely the entire auroral spectrum, though it showed also a number of foreign lines, due probably to the presence of oxides of C and N in the discharge tube. In estimating relative intensities of the auroral bands, says *Terrestrial Magnetism,* the arbitrary values 9 and 12 were given respectively to the bands of wave-length 428 and 392 tenth-metres. Many of the weaker bands, however, were sometimes absent altogether, making an accurate comparison with the intensities of the cathode discharge bands impossible.

Trolley Currents and Magnetic Observatories—At the magnetic observatory in Parc St. Maur, near Paris, great disturbances were noticed in the recording instruments owing to a neighboring trolley line, which passed at a distance of 3,200 metres. The effect was not a continuous displacement of the needles, but a series of symmetrical, though irregular, vibrations about their normal positions. This fact led to the hope, says *Terrestrial Magnetism,* that those movements due to the electric current might be suppressed without impairing the value of the photographic curves. For this purpose the following means were employed on the bifilar and declination instruments: First, bar magnets five centimetres long were placed below the needles; second, each needle was weighted until its moment of inertia had been increased one-third; third, a copper damper was placed close to the face of each needle. Comparisons were made between the instruments thus modified and another set of the usual form. Three different stations were occupied at varying distances from the car line: 1. Tramway 3,200 metres distant. The normal bifilar showed disturbances as great as 0.0002 centimetre-gramme-second units, while these oscillations disappeared completely on the modified instrument. 2. Tramway 1,050 metres distant. Disturbances on the normal bifilar frequently greater than 0.0003, which were reduced on the modified instrument to 0.00003. 3. Tramway 240 metres distant. Effect on normal bifilar of the order 0.0005; on modified bifilar, 0.00005. The disturbing oscillations were thus reduced in the ratio of 10 to 1. A comparison of the curves seemed to indicate that minute changes in the earth's magnetism were as faithfully recorded on the modified instrument as on the one of normal form.

Arc Spectra—In the *Astrophysical Journal,* Professor Henry Crew describes some very interesting experiments he has recently made on the differences in the spectra of various metals when the arc producing the light was surrounded by ordinary air or hydrogen. The investigation was undertaken in the hope that the new condition might have some selective effect on the spectrum lines, and thereby facilitate their grouping into series. The arc was produced in a brass hood made in two halves; into one of these the two electrodes were fitted by insulated bearings, provision being made for one of the electrodes being rotated from outside. The opposing edges of the two hemispheres were then screwed together and a gas-tight joint obtained. Opposite the space between the poles, the hood was provided with an opening carrying a brass tube some 12 inches long, having at its outer end a quartz lens which served to project an image of the enclosed arc on to the slit of a concave Rowland spectograph of 10-foot radius. The hydrogen was supplied from three large electrolytic cells, and, after passing through a drying tube, was allowed to continually pass through the brass hood, the surplus being ignited at a stopcock. The first indication of the effect of the hydrogen was to materially diminish its intensity, so much so that in some cases the exposure had to be from five to one hundred times that necessary in air only. In addition there is a most conspicuous change of relative intensity among the lines of any one substance. Tables are given of the lines affected in the cases of magnesium, zinc and iron. In magnesium, the characteristic line at wave-length 4,481 has an intensity in hydrogen 10 times as great as in air, this change being similar to that obtained in passing from the arc to the induction spark. In the case of iron many lines are greatly enhanced in intensity, but these are not the same lines which are enhanced in substituting the spark for the arc condition; but the author states that all lines in the arc spectrum which are affected by the hydrogen atmosphere, whether enhanced or diminished in intensity, belong to the spark spectrum also. On the other hand, the lines which belong to Kayser and Runge's series are unaffected by the change from air to hydrogen.

SYNCHRONOUS CONVERTERS.*

BY W. E. GOLDSBOROUGH.

In the practice of his profession, the electrical engineer is constantly facing radical amplifications of the one time limitations of his field for work. To those of us whose daily occupation is largely confined to the successful commercial management of electrical enterprises, the business details connected with which tax our attention, these changing conditions are often perplexing, while their multiplicity reduces rather than stimulates our curiosity regarding them. In this, as in other fields, however, fortune favors us. Time attacks the "invincible formulæ" in which our seers clothe their theories, and gradually intricacies unfold until comparatively simple illustrations suffice to make clear seemingly complex phenomena.

This paper treats of one of the most useful electrical devices that the end of the century has placed at the disposal of the engineer, and I trust the paper may in some measure extend your appreciation of the worth of the device.

The synchronous converter is the chief exponent of a type of machine that embodies a greater number of the principles underlying the design and construction of dynamo-electric machinery than any other apparatus used in the development and distribution of electric power. And yet, it is in many respects a wonderfully simple machine. The direct-current dynamo has been in use, relatively, for so long a time, and we have become so familiar with it, that it is no longer regarded as a complicated mechanism. In the same way the alternator is so frequently met with that it has become a well understood part of station equipment. In fact, the direct and alternating-current dynamos have been partners from the first, and we instinctively associate them together. But who does not look with interest at the modern "rotary" or synchronous converter?

The combination of the direct and alternating-current machines into a single unit has resulted in the production of a marvelously ingenious device, and made the link between the two great divisions of electric power distribution. It is a machine which, when belt-driven, develops either direct or alternating-current power, either separately or simultaneously. Under these conditions it will fulfill the functions of either a direct-current generator, an alternating-current generator, or a double-current generator.

If, on the other hand, it is operated electrically from a source of direct-current power, it can be used either to develop mechanical power as a shunt motor or as a source of alternating-current power. In the latter case, the machine is frequently called an "inverted-rotary."

And, finally, the machine can be operated from an alternating-current source of power either as a synchronous motor developing mechanical energy, or as a producer of direct-current electrical energy. The last-mentioned arrangement is the most common condition of operation of the machine, and when so used it is known as a "rotary" or a synchronous converter.

The synchronous converter is, then, properly speaking, a device for converting alternating into direct-current power.

In view of the fact that practically all electrical rotating machinery is now equipped with a distributed coil form of winding, the statement is not surprising that any direct-current, constant-potential generator can be changed into a synchronous converter by suitably tapping the armature coils and leading the taps out to collector rings. Or, that any alternator having a distributed winding can be made into a "rotary" by suitably tapping the junction terminals of adjacent armature coils and connecting them to a suitable commutator. In designing a synchronous converter, the latter practice is substantially what is followed, with the result of producing a machine suited to the limitations imposed by frequency considerations, as well as to the other factors governing the conversion of power.

To gain an insight into the theory of the working of these machines, let us for a moment consider the working conditions in direct-current generators and motors. If a shunt dynamo is operated with a given field excitation and at a given speed, a given electro-motive force is maintained at the brushes for any specified condition of loading. If the same field excitation is given to the machine, and the same electro-motive force impressed at its brushes, the machine will operate as a motor; and the direction of its armature rotation, the strength of its armature current and the power it develops will be the same, assuming 100 per cent efficiency.

But, although the armature currents in the machine in the two cases will have the same intensity, they will flow through the armature conductors in opposite directions.

Now, consider the case of an alternator. With a given excitation, speed and load, the machine will develop a definite voltage, when driven as a generator of alternating-current energy. If, however, the machine is driven electrically, with the same field excitation, the same direction of rotation, the same speed and the same impressed voltage, it will develop an amount of mechanical energy that is exactly equal to the electrical energy previously developed, but the direction of the flow of current in the armature at corresponding instants of time will be opposite in the motor to what it was in the generator. Of course, for the moment we are neglecting all losses inherent to the machine, and considering that it has an efficiency of 100 per cent, and that the line constants are such as to reduce the operating constants to electrically the same terms.

That is, if the machine has an (assumed) efficiency of 100 per cent, other things being equal, it develops as a synchronous motor an amount of mechanical energy that is equal to the electrical energy it develops when operated as a generator; but *the current flowing in the armature windings is reversed in the two cases.*

It may be generally stated, then, that if constant field excitation and constant direction of armature rotation be maintained, the flow of current in the armature of any electric machine when used as a generator is opposed to the flow of current in the armature when the machine is used as a motor.

If we consider a machine having two independent direct-current windings on its armature, the terminals of the coils of which are brought to separate commutators (a commutator being placed at each end of the armature body), we have a combination that is known as a dynamotor. Every other slot in the armature core contains the conductors of the first winding, and the intermediate slots the conductors of the second winding.

If the first winding is adjusted for 110-volt work at 90 amperes, and the second winding for 220-volt working, it is possible to draw 45 amperes at 220 volts from the second winding, if the first winding is connected to 110-volt power mains. In other words, assuming 100 per cent efficiency still, the machine operating as a motor from the 110-volt mains, develops the same amount of power in its second or generator winding that it absorbs in its first or motor winding, but at an increased voltage. The current in the second winding will, however, be flowing in a direction along the slots that is opposite to the direction of the current in the conductors of the first winding. Such a machine is a transformer or converter of direct currents, as it transforms the direct current to a higher voltage, and thereby performs the function that, in alternating-current working, is characteristic of the static transformer.

Attention has been called to the fact that practically the same form of distributed coil winding is now used for both alternating and direct-current armatures. When all of the junction points of adjacent coils are brought down to commutator bars, the winding suffices for a direct-current generator. When only the junction points under the centres of the poles (for a given position of the armature) are brought down (those under the [N] poles being connected to one collector ring, and those under the [S] poles being connected to another), the winding suffices for a single-phase alternating-current generator.

From the dynamotor just considered, the commutators can be removed and collector rings substituted, with suitable taps connecting the two sets of collector rings to evenly spaced coil junction points on the first and second armature windings respectively. A machine results which, when connected to an alternating-current

*A paper read before the Northwestern Electrical Association, Milwaukee, Wis., January 16-18, 1901.

circuit (of proper frequency), can be made to operate as a synchronous motor, developing in the second winding alternating-current power to the same amount, but of double the voltage. Here, then, we have an unusual type of alternating-current step-up transformer. The transformation differs essentially from that which takes place in the static transformer simply in that the core over which the coils are wound rotates. The first winding is the primary, the second the secondary, and in these windings, as in the windings of the static transformer, the currents in the primary and secondary flow in opposite directions. This machine has no place in commercial development, as the static transformer performs all the functions of which it is capable better and cheaper, but the machine is worth considering as a link in the chain of our discussion.

Now, let us go back and consider a further modification of the dynamotor. Suppose it were wound with two identical direct-current windings. Then, as the first winding is exactly like the second winding, the voltage at each commutator would be 110 volts, and the ratio of transformation between the two ends of the machine would be unity. Currents of equal intensity would flow through conductors of equal section in the two armatures, and all magnetic effects due to the currents in one winding would be completely annulled by the currents in the other winding. The armature would simply spin in its bearings, giving out to one circuit what it took from another, as long as its efficiency was maintained at the assumed value of 100 per cent.

An alternating double-current armature corresponding to the above would transform its energy at the same unit ratio, and could be operated as free from all reactions of armature currents upon its fields; the currents in the first and second windings in this instance also completely annulling one another's magnetic effects.

Now let us make another change. Take from the armature body one of the two identical direct-current armature windings, and replace it by one of the two identical alternating-current armature windings of the machine just considered. If the resulting machine is supplied with alternating-current power at 78 volts, it can be operated as a synchronous motor; and from the second or direct-current winding, direct-current energy can be drawn at a voltage of 110 volts. As by our previous assumptions the machine develops and delivers 10 kilowatts of power, the alternating current will have to have a value at least as great as 128 amperes, to produce the required 90 direct-current amperes. This machine, which we may call a "synchronous dynamotor," is but one step removed from the synchronous converter. As it has two independent windings, there is no electrical contact between the two systems. Alternating-current power is supplied and direct-current power delivered, and the net effect of the currents is that they flow in opposite directions through the conductors of their respective windings. As the alternating currents vary in intensity from zero to maximum values, while the direct currents are to all intents and purposes constant, we have the condition of a fluctuating quantity opposite to a constant quantity. Therefore, at any given instant, the net magnetizing effect of the armature currents may or may not be zero, according as instantaneous values of the alternating currents are equal to, or are less, or are greater than the direct currents; but the average magnetizing effect of the working component of the alternating current is exactly balanced by the magnetizing effect of the direct current. When, therefore, a converter of this double-winding type is adjusted to maximum economic working, the armature exerts practically no influence upon the magnetic conditions existing in the field circuit.

So far we have assumed an efficiency of 100 per cent for the several machines considered; an assumption which, unfortunately, can never be realized. The "synchronous dynamotor" discussed in the last paragraph has its defects, in spite of all assumptions. When running free and without load, the power required to overcome the hysteresis and eddy currents of the armature core and the exciting energy required by the field winding are the chief losses. As the load comes on the machine at the direct-current side, greater and greater currents flow in the double windings, and to the no-load losses must be added at full load the copper losses of both the first (or alternating) and the second (or direct-current) armature windings.

In a set consisting of an independent synchronous motor and a direct-current generator mounted on the same base and directly connected, we have to contend with a field copper loss, a friction loss and an armature copper loss in each machine. In a synchronous dynamotor, the field copper loss, the friction loss and the core loss are reduced, but the armature copper losses remain the same as in the case of the two independent machines. Now, if we could get along with one winding on the synchronous dynamotor armature, confining both the alternating and the direct currents to *one* winding, a great gain would be effected. The direct and alternating currents would be flowing in opposite directions in common conductors, and tend to annul one another. Such an arrangement would entirely remove the copper loss of one winding and greatly reduce the copper loss of the other.

The synchronous converter is the machine in which this principle is carried out. The junction points of the coils of the distributed winding on the armature of a synchronous motor (whether it be a single-phase, a two-phase or a three-phase machine matters not) are tapped and connected to the bars of a commutator. As a matter of convenience the collector rings are usually placed at one end of the armature body and the commutator at the other. This is the only modification commonly made in the machine. It is then speeded up and brought into synchronism with the supply circuit in the same manner as before the commutator connections were added. Instead of loading the machine mechanically, however, the load is applied by taking off direct-current power from the commutator. Since there is but one winding on the armature, the direct currents are drawn from the same winding to which the alternating currents are supplied. In a measure it is true that the alternating current never enters the winding of the machine at all. A large part of it never does, but flows directly into the direct-current mains, since twice in every oscillation of the alternating current the direct current entirely neutralizes the alternating current in the windings. Outside of the armature windings, however, the direct and alternating currents at these times are flowing in the same direction. What current there is flowing in the armature winding is made up of the differences in the instantaneous values of the (constant) direct and (variable) alternating currents in the various armature conductors.

The reduction of the average current intensity in the armature conductors greatly reduces the dimensions of a machine for a given capacity below what is required for either an ordinary synchronous motor or direct-current dynamo of similar capacity. This is a matter of considerable importance and a feature not to be overlooked.

As presented thus far, my paper may seem to treat particularly of the single-phase converter. It is not my desire, however, to limit the discussion to any special type of converter, but had it been, I should not have chosen the single-phase type. Of all synchronous converters, the single-phase converter is commercially the least useful, and although it is well adapted to the illumination of explanatory matter, it is not well suited to the needs of practice. However, what has been said regarding the single-phase converter is equally true of the polyphase converter; in fact, it is true of it in an even greater measure. In the polyphase machine, such reactions as do exist are less abrupt than in the single-phase machine; they follow one another in a smoother and milder fashion, and, as with people of similar characteristics, are easier to get along with.

With this conception of what goes on beneath the surface of the all-important armature, we can profitably turn to a review of some of the important characteristics that make the converter so valuable an auxiliary in the distribution of power.

Mention has already been made of the fact that if a given alternating-current voltage is impressed at the collector rings of a converter we do not get the same voltage between adjacent sets of brushes that we do between adjacent collector rings. The direct-current voltage will always be greater than the alternating-current voltage. This is because the crest of the wave of alternating electro-motive force can not have a greater value than the maximum electro-motive force generated in the armature conductors that act in series between phase connection taps. Moreover, since the effective value of the alternating electro-motive-force wave is

only $\sqrt{2}$ times the maximum value, it is not possible for the effective alternating electro-motive force ever to equal the direct-current electro-motive force; the direct-current electro-motive force being equal to the maximum electro-motive force which can possibly be generated in the maximum number of armature conductors which it is possible to have acting in series at any one time.

The table given below shows just what the theoretical voltage and current ratios are in different types of converters. They are the results derived mathematically by Mr. Steinmetz, and illustrate with accuracy the conditions that obtain in practice. The constants given assume harmonic voltage and harmonic current waves, and no allowance is made in the voltage ratios for the copper losses in the windings. In practice, therefore, a variation of as much as 15 per cent may be found from these values, although the departure is not often more than five per cent.

TABLE I.

COMPARATIVE CAPACITY RATIOS OF DIFFERENT TYPES OF SYNCHRONOUS CONVERTERS.

	Direct Current.	Single Phase.	Three Phase.	*Four Phase.
Volts between adjacent collector rings.	1	.707	.612	.5
Amperes per line.....	1	1.414	.944	.707
Ratio of copper loss in rotary converter to copper loss of same machine operated as a direct-current generator at the same output.....	1	1.37	.555	.37
Relative capacity of rotary converter, and same machine operated as a direct current generator at the same temperature.....	1	.85	1.34	1.64

*Called two phase.

One of the most important characteristics of the rotary converter, and one which it shares in common with the synchronous motor, is the ease with which it lends itself to the regulation of the power factor of the circuit from which it is operated. If the rotary is "under excited" it will act like an impedance coil connected in the line, and produce a lagging current. As its excitation is increased, if the load is kept constant, the current comes more nearly in phase with the impressed electro-motive force, and at the same time is reduced in value. Finally a point is reached at which the armature current is in phase with the impressed electro-motive force, and the armature current is then a minimum for the given load. Any further increase in the field excitation causes the converter to act as a condenser in the line. "Over-excitation," therefore, causes the armature current to increase again, as well as to attain an angular advance over the electro-motive force. The machine can therefore be adjusted to counteract the inductive effects of induction motor and transformer loads, and when once set for a given power factor by a given adjustment of the field current, it will maintain this power factor practically constant for all loads. When operated from generator mains supplying power to well-loaded transformers, a synchronous converter should be adjusted to a power factor of 100 per cent, as the power factor of the transformers will closely approximate this value. When so adjusted, a good rotary will maintain this condition at all loads. This statement refers primarily to uncompounded machines, or to the simplest form of synchronous converter connected up and operated in the simplest manner.

With such an adjustment the converter will not maintain a constant pressure at its direct-current terminals, if the shunt field current remains constant. Under this condition, with constant generator impressed electro-motive force, since the speed remains constant, the alternating electro-motive force induced in the converter windings remains constant. The alternating electro-motive force at the collector-ring terminals will, however, usually fall off slightly as the load comes on, owing to the relative phase position of the impedance armature drop electro-motive force, and the induced alternating armature electro-motive force. The direct-current voltage at the commutator brushes diminishes with constant field excitation as the load comes on, due to the loss of voltage in the armature and commutator resistances.

If it is desired to maintain a constant voltage at the commutator, or to have the direct voltage increase with the load, provision must be made either for increasing the impressed alternating voltage or increasing the excitation of the converter fields.

In the first instance induction regulators can be successfully employed to increase the impressed electro-motive force, or if automatic regulation is needed, booster transformers can be inserted in the circuits. These should have their primaries connected across the alternating mains and their secondaries connected in series with the mains.

The regulation for constant or increasing voltage at the commutator that is effected by varying the field current can either be accomplished by hand adjustment of the shunt field resistance, or automatically, by placing a number of compounding turns on the field spools and connecting these in series with the direct-current leads from the commutator brushes. To make this regulation effective, there must be considerable self-induction present in some part of the alternating circuit, and if this is not inherent in the machines or characteristic of the line from which the converter is operated, impedance coils must be connected in the mains to make up for the deficiency in the inductance of the system.

When proper line constants are assured, the field excitation should be so adjusted at light loads as to promote lagging currents in the system; *i. e.,* the converter fields should be under-excited. With this adjustment as the load comes on, the series winding, by strengthening the field, will cause the low initial power factor of the system to increase and the line current to come more nearly in phase with the electro-motive force. Finally, the electro-motive force and the current will be in phase and the power factor have reached a value of 100 per cent. If it is desired to maintain constant voltage at the converter brushes, the adjustment should be such as to produce the 100 per cent power factor at full load. If upwards of 10 per cent compounding is desired at full load, the initial excitation should be adjusted to promote the inphase condition at about three-quarters load.

Frequency considerations are very important when synchronous apparatus is to be used. In the case of converters it is very difficult to produce machines that will operate with satisfaction at high frequencies. Machines designed for 125-cycle working have such high commutator peripheral speeds, such narrow commutator bars, and consequently such short commutating periods, that it is hard to bring their mechanical construction into harmony with the electrical requirements. Synchronous converters working at 60 cycles represent the upper limit of successful operation; and at 40 cycles and 25 cycles the best results are obtained. Machines constructed for 25 cycles differ in but slight details from the lines followed in the construction of standard direct-current machinery.

For successful working, it is necessary that a synchronous converter be equipped with an armature having rather high inductance. This means that the coils are placed in deep slots, and that teeth with projecting heads are not objectionable. Machines with small armature self-induction do not compound so readily and are prone to "hunt." By "hunting" is meant a variation in the speed of the converter that is frequently induced by instability in the frequency of the source of supply. In trying to adjust itself to the changing conditions of frequency, an armature having little inductance does not possess the same power of "holding on" that is inherent to an armature having high inductance, and consequently it is liable to not only develop large idle currents, but to fall out of synchronism.

In starting up synchronous converters from the alternating-current side, the exciting circuit should be opened, and it is also advisable to disconnect the field spools one from another, as an undesirably high voltage is likely to be induced in the field windings. Without this precaution, the induced voltage may break down the field-spool insulation.

Owing to the fact that the starting current often exceeds by 50 and even 100 per cent the full load running current of the machine, it is likely to produce serious voltage fluctuation in the distributing system. Auto-transformers are, consequently, often used in starting. They reduce the line voltage and consequently the starting current, and can be cut out when the speed of the machine has risen an appreciable amount.

When a converter is started from the alternating-current mains, an alternating electro-motive force is apparent at the commutator brushes, the frequency of which diminishes as the speed increases. Near synchronism this electro-motive force pulsates very slowly, and if lamps are connected across the brush leads, by

their pulsating light they give an indication of the per cent of synchronism attained. When synchronism is reached, the field circuit should be closed. The load can then be put on the converter.

A synchronous converter can also be started from the commutator end of the machine. In this case the same precautions must be taken that are observed in starting a shunt motor, and the machine must not be thrown in with the alternating-current generator until the right phase relation of the currents is attained, as indicated by synchronizing lamps or other appropriate devices.

The Philadelphia Automobile Show.

As previously announced in the ELECTRICAL REVIEW, the first automobile show to be held in the city of Philadelphia will open on February 4 and close on February 9. The show will be held in the Second Regiment Armory, and is under the sanction of the two Philadelphia automobile clubs. Over 50 automobile manufacturers have engaged space, and the ELECTRICAL REVIEW is informed that the show promises to be a great success. The Pennsylvania Automobile Club, 138 North Broad street, Philadelphia, has extended the courtesy of its house to visiting automobilists.

Patent Office Report for 1899.

United States Patent Commissioner C. H. Duell has issued his official report for the year of 1899, and the totals as shown therein are of considerable interest.

The total receipts from all sources reach the large amount of $1,325,457.03, while for the same period $1,211,783.73 were expended.

A summary of the routine business of the Patent Office shows that 38,937 applications were filed for patents on inventions, 2,400 for designs and 106 for reissues of expiring patents, making a grand total of 41,443 applications filed. Caveats, registrations, disclaimers and appeals on the merits were filed to the number of 5,500, thus bringing the figures for all applications requiring investigation to 46,943. Seven and eight patents were issued respectively to the army and to the navy, while 22,124 patents were granted to citizens of the United States as against 2,311 issued to foreigners.

The first patent granted in America was on July 28, 1836, under the present system of numbering, and the patents issued prior to that time numbered altogether 9,957.

Commissioner Duell closes his report by asking the question: May not our inventors hopefully look to the Fifty-sixth Congress for aid and effectual encouragement in improving the American patent system?

NOTES ON LIGHT.

BY WILLIAM ROLLINS.

NOTE CXIV—ON BALANCED CATHODES.

In earlier notes I showed that cathodes lost in weight, some losing more than

FIG. 90.—A SMALL "SEEHEAR."

others with the same amount of electricity. As this is a point of theoretical importance, I figure one of the methods I used. The cathode is made one arm of a balance.

NOTE CXV—CATHODES OF RADIO-ACTIVE SUBSTANCES.

I made an aluminum cathode turning up the edge to act as a rim, to prevent the

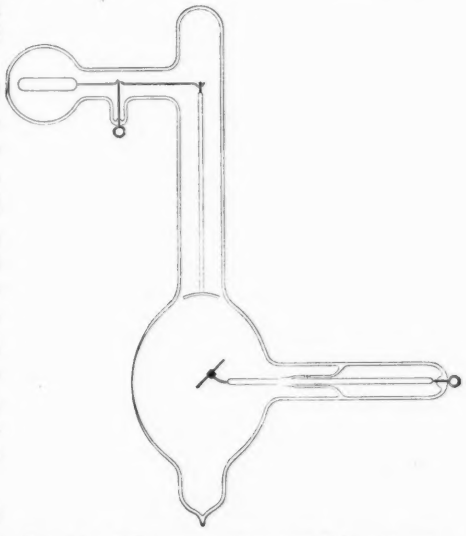


FIG. 91.—A BALANCED CATHODE X-RAY TUBE.

layer of radio-active material from falling off the surface of the cathode, which it covered to the depth of two millimetres.

The target, of platinum, was made with a hinge, that it might be turned out of the way to enable the radiations to pass unimpeded through the tube to the thin wall opposite the cathode, beyond which was placed the photographic plate. Before exhausting the tube a plate was exposed. The tube was then exhausted by heat and heavy surges until no current could be made to pass through it. Another plate was then exposed to the radiation. It is interesting to note that the power of the radiations was increased.

NOTE CXVI—A SMALLER SEEHEAR.

In a larger form with open screen this instrument was figured in this journal for February 8, 1899. The instrument contained two principles new in stethoscopes; one a sound chamber, the other a fluorescent screen in connection with a sound chamber. The former has since been adopted in one of the stethoscopes in common use. The latter awaits recognition. As shown in the figure, the fluorescent screen is about seven centimetres in diameter. The sound chamber is one centimetre in depth, the wall toward the patient being of thin hard rubber or other radiable material. There certainly is an advantage in hearing the sounds in the chest while the organs are under inspection and as I have designed comparatively cheap apparatus, giving plenty of

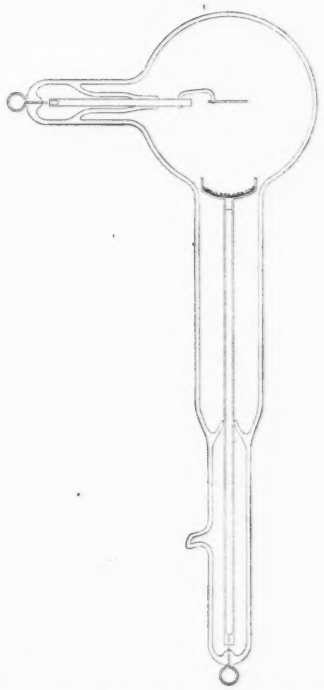


FIG. 92.—X-RAY TUBE WITH RADIO-ACTIVE CATHODE.

X-light of suitable quality, such an instrument as the seehear should be used more extensively than it has been. Perhaps in the form now shown it may be more appreciated.

Electric Lighting

A new electric light plant at the Raleigh, N. C., penitentiary has been installed and is in full operation.

Bonds are soon to be issued to provide for electric lights for Nicholasville, Jessamine County, Ky.

Surveys are being conducted for a pipe line to convey water from the Walla Walla River to the Athena, Ore., Electric Light and Power Company.

Galena, Ill., is soon to have a new electric lighting plant which will cost, according to present estimates, about $18,000, and will operate for about $5,000 a year.

The city council of Republic, Wash., has granted a charter to M. L. Bervis for an electric lighting plant to be operated by water-power derived from the San Poil.

Indianapolis, Ind., capitalists are said to be negotiating for the purchase of Bloomington electric light plant, and if successful will add to the plant a hot-water heating system.

The village authorities of Westfield, N. Y., recently voted to purchase new machinery for their electric light plant sufficient to increase the capacity to 2,000 incandescent lights.

The Common Council of La Porte, Ind., has ordered a renewal of the electric light contract with the La Porte Electric Company for the ensuing five years, the light to be furnished every night in the year.

Waterbury, Ct., has taken steps looking toward the ownership of an electric light plant to supply that city, and the aldermen have been requested to authorize the issue of $100,000 in bonds to provide for the enterprise.

City Electrician Charles F. Hopewell, of Cambridge, Mass., recently recommended that the overhead wires of that city be taken down and placed in underground conduits as a result of the deaths of several persons by shocks in the preceding year.

The Auburn, N. Y., Electric Light Company went out of existence on December 31, 1900, and on January 1 its name was changed to the Auburn Light, Heat and Power Company. The officers and management remain the same.

According to a German newspaper, the *Rheinisch Westphalische Zeitung,* an electrical firm has made successful experiments in utilizing wave-power at sea to generate current for electrically lighting channel buoys off the Holstein coast.

The building committee of the supervisors of Peoria, Ill., recently determined to ask estimates and bids for an electric lighting plant for the court-house and jail. An approximate estimate showed that a plant of the required capacity would cost in the neighborhood of $6,500.

A combination of lighting interests has been effected at Long Branch, N. J., by the merging of the Seabright Electric Light Company and the Shore Electric Light Company, of Redbank. Philip N. Jackson is president of the corporation, which will be known as the Shore Electric Company.

The town board of the village of Roslyn, L. I., has accepted the bid of the Roslyn Electric Light and Power Company for lighting that village, and within the next few months 100 30-candle-power incandescent lights will be in operation throughout the town at a uniform rate of $15 per year.

Despatches from Chippewa Falls, Wis., state that the plant of the Chippewa Falls Light and Water Company is being enlarged to supply power to the Chippewa Valley Electric Railway Company, to whom the company has leased a certain amount of power for the operation of its cars from that city to Eau Claire.

Present contracts for electric lighting in Utica, N. Y., expire in the Fall. A new contract will be awarded some time in November. The annual cost of lighting the city is now about $70,000 and efforts will be made to have the council ask for bids on a long-term contract, the present contract being only for five years.

Capitalists of St. Louis, Mo., are seriously considering the proposition of erecting and maintaining an electric lighting plant, as the company operating the present city plant has raised its prices, which took effect on January 15. This action was the cause of the patrons gathering to consider the new plant proposition.

The Conshohocken, Pa., Electric Light Company is rebuilding its entire plant and line in that city. During the past year new poles and wires have been erected and strung and the capacity of the company considerably increased. Plans have also been made for the erection of a brick building 100 by 56 feet for the company's power-house.

Electrical progress in Spain is rapidly increasing. There are now altogether 145 electrical power-stations in that country and among the most recent enterprises is a new stock company formed at Cartagena with $1,500,000 capital. This company will build a large power plant in that city to supply the iron-ore mining district in the immediate district with light and power.

Citizens of New Castle, Del., are endeavoring to secure the bonding of the city to obtain money for the erection of a new electric lighting plant and waterworks. If successful this movement would mean that the city in 10 years would own its own plant and have an adequate supply of water, which it does not now possess. This would be of particular advantage in case of fire.

Cleveland capitalists have recently been in Mt. Vernon, Ohio, looking over the city electric light plant and electric railway at Hiawatha Park, with a view to purchasing the entire combination. The gentlemen refuse to make any definite statement concerning the matter, stating that it is only preliminary so far, but it is generally believed in Mt. Vernon that some definite action will be taken in the near future.

The board of electrical commissioners of the city of South Norwalk, Ct., has issued its eighth annual report for the fiscal year ending October 12, 1900, and combined with it is a special report on the enlargement of commercial electric lighting systems. The pamphlet which contains the two printed reports also embodies the local fire-alarm rules, a description of the city's plant and an ordinance relative to the electrical works.

The recently enlarged electrical power plant in the northeastern basement corner of the city hall of Philadelphia, Pa., has been tested and found successful. Two large engines have been installed which, with the other three, give a running lighting capacity of 16,500 candle-power. Each machine is of 300 horse-power energy. The installation was made at an opportune moment, as during the twentieth century celebration 13,000 incandescent and arc lights were used about the building.

It is stated on good authority that the Port Jefferson, L. I., Electric Light Company has offered to pay the taxes for any resident widow who feels unable to meet the increased tax which would result from the establishment of a lighting plant in that district. The citizens of Port Jefferson are said to desire greatly an electric lighting plant, and to help them along the company has made the proposition mentioned above, which it hopes will increase its chances on getting the contract.

Electrical Printing Paper Perfected by English Photographer.

Printers are said to be much interested in the work of an English photographer, a Mr. F. Greene, of London, who has met with considerable success in producing a paper by means of electricity which may be printed upon without employing inks or the use of any previous sensitizing matter by saturation, as has heretofore been done.

Instead of saturating this "electrographic" paper with the sensitizing materials as has hitherto been done, it has been found best to mix them with the pulp in the process of manufacture, and so a radical departure has been made and a new machine-made paper has been invented that has rare properties. The chemicals used are abundant and cheap, so that this paper can be produced as cheaply as common paper. The prepared paper is stable and colorless, is unaffected by any other agent than the electric current; may be kept indefinitely and sent to the press directly from the roll as manufactured, with no preliminary treatment whatever; yields instantly a dense black, permanent print, requires no subsequent fixing or developing; indeed, is ready for distribution immediately, as there is nothing like ink to smirch or require drying; briefly, it meets all the requirements of a perfect medium for electric printing. The machine for electric printing is simply an ordinary press divested of all its inking mechanism and having the cylinder or paper-bearing surface covered with a suitable conducting metal. The work of "make-ready" is the same as for ordinary printing, and line blocks, electrotypes, woodcuts, half-tones, engravings, all kinds of designs in relief may be used at will. The form is connected with one pole of the dynamo or battery—for most purposes the current may be taken from an ordinary incandescent light wire—the paper-carrying cylinder or surface is connected with the other pole. Thus the metal surfaces of both cylinders are the electrodes, while the paper is in reality a very thin cell in which the pulp is an inert medium and the contained chemicals the electrolyte which is to be subjected to electrolysis. As the cylinders approach each other to press the paper as it is fed between them, the current is switched on automatically and flows from one cylinder through the paper at the points of contact to the other cylinder, the impression being produced instantly by electrochemical action. The paper possesses conducting properties, so that the voltage used may be from 10 to 110 volts, and four amperes for the largest machines. All inking mechanism being dispensed with, the power required to drive the press is much less. For a given piece of work, the cost of current for the actual printing is said to be only one-half that of ink, while at least a saving of one-third in the cost of presses is assured. The new process lends itself readily to all speeds, even to the fastest web presses. At an exhibition at Blackpool, England, witnessed by a large company of printers and scientists, a rotary press was run at the rate of six thousand impressions per hour, and the work was declared perfect in every particular. Relative to the appearance of electric printing, the *Journal of Printing and Kindred Industries of the British Empire* says it greatly resembles lithographic work. It is reported that several of the great London dailies have placed their plants at the disposal of the invention for an exhaustive test of the process.

American Institute of Electrical Engineers' Meeting.

A regular meeting of the American Institute of Electrical Engineers was held last Wednesday evening, January 23, at the house of the American Society of Mechanical Engineers, in New York city. Papers by Professor W. E. Goldsborough on "Air-Gap and Core Distribution" (this being the third of a series of papers by the same author on this subject), and by Mr. W. B. Vansize, on the "Murray System of Page-Printing High-Speed Telegraphy," were presented. Professor Goldsborough's paper was read by title, and Mr. VanSize's paper was read at length by the author and illustrated by means of lantern slides, and also by an exhibition of the receiving apparatus of the Murray system. Mr. Donald Murray, the inventor of the system, was also present and assisted in explaining its operation. This paper appears elsewhere in this issue of the ELECTRICAL REVIEW. A number of candidates for membership were announced as having been admitted by the examining committee.

Australian Electrical Tenders.

The Department of the Public Service Tender Board, 42 Young street, Sydney, N. S. W., will ask for bids until February 22 next for the supply of telegraph, telephone and electric light material for 1901-1902. Tender forms may be obtained at the office of the Chief Electrician, General Post Office, George street, Sydney.

PERSONAL.

Mr. Thomas A. Edison expects to leave his home at Orange, N. J., about the middle of February for a month's vacation in Florida.

Mr. Clinton L. Rossiter was reelected president of the Brooklyn Rapid Transit Company at a meeting of the company's directors held on January 28. All the other officers were reelected.

Mr. F. Z. Maguire, of Maguire & Baucus, the European agents for numerous American electrical houses, returned to London this week after spending a fortnight in New York city. Mr. Maguire reports that the interest in the manufactured product of American electrical houses is constantly increasing as is also the demand not only throughout England but on the Continent.

Mr. F. A. Wunder, for many years representative in New York city of the Fort Wayne Electric Works and the Siemens & Halske Company, will hereafter represent, as general sales agent, the Ball Electric Company, of New York city, with headquarters at 95-97 Liberty street. Mr. Wunder is an experienced electric light man and will be warmly welcomed by numerous friends upon his return to active work in this field.

Mr. J. W. Peterson, of Chicago, has associated himself with the Chicago office of the Northern Electrical Manufacturing Company and the Stanley Electric Manufacturing Company, and will hereafter direct his efforts toward selling the apparatus of these two companies. Mr. Peterson enjoys an extensive acquaintance with western manufacturers, and will now have an opportunity of adding to his reputation as a selling engineer.

Telegraphic Communication with Pekin, China.

Telegraph lines have been strung overland in China between Tien-Tsin, Taku and Pekin by the Great Northern and the Eastern Extension companies. The present lines have been designed to operate in connection with the neutral cables laid last year between Shanghai, Chefoo and Pekin. The Tien-Tsin and Pekin stations were opened for business on January 26.

The Craze for Office.

A California paper gravely states in its editorial column that "A street car in Newcastle, Pa., jumped the track yesterday and rushed full tilt into the City Hall. This rage for breaking into public offices seems to be growing."

Electric Railways

After five months of operation the Central London Underground Railway has declared a dividend equivalent to three per cent per year.

Ithaca, N. Y., is likely to have a trolley line in the near future connecting it with Auburn. The line will run along Skaneateles Lake from Cortland to Auburn.

Fulton County, Pa., is said to have raised $50,000 to secure the construction of a railroad from the Baltimore & Ohio station, at Hancock, Md., to McConnellsburg.

Contracts have been let for the construction of the Montour & Columbia Railway Company, in Montour County, Pa. The road will be in active operation within the year.

Repairs at the power-house of the Rochester Railway Company have been successfully effected and trolley-car service was resumed throughout the city after a delay of a day or so.

A new series of reduced passenger fares has been ordered into operation by the president of the New York Central Railroad to meet local competition of suburban trolley lines in western New York.

The Toledo, Fremont & Norwalk Electric Railway Company has given an order to the Massillon Bridge Company for a bridge over the Huron River, near Monroeville. It will be a 290-foot bridge.

The significance of the Westerly, R. I.—New London, Ct., electric railroad is said to lie in the fact that when finished it will furnish an important link in the New York and Boston shore-line electric route.

Mayor Hayes, of Baltimore, Md., recently signed the "omnibus curve ordinance," which is said to have marked the final step in the consolidation of the street railways of Baltimore into a single system.

It is said that the Pennsylvania Railroad intends to build an electric railroad to carry coal and limestone from Volant into the new coal fields in the eastern part of Mercer County, averaging about 1,500 tons a day.

At the recent election in Barberton, Ohio, the residents of that city voted for a new electric light contract, the vote standing 690 to 25 in its favor. At present, the Akron & Cuyahoga Falls Rapid Transit Company furnishes the light.

An electric railroad will be built in the near future by the Queenstown, Niagara & Port Dalhousie Electric Company, which has been recently incorporated for $40,000. The line will run from Queenstown to St. Catherine's *via* Niagara and Port Dalhousie.

Franchises have been granted by Brooke County to the Northern Ohio Valley Railway Company, which will run from Wellsburg to the Ohio County line. The company has been required to give a $10,000 bond to build the road within 18 months and to begin work within 90 days.

An effort is being made in Buffalo, N. Y., to organize a new company which will be capitalized at $800,000 out of the Buffalo, Hamburg & Aurora Street Railway Company. The new company's line will extend 40 miles to Cattaraugus, opening up a country which has hitherto had no electric railway facilities.

Among contemplated improvements in the Klondike is an electric railway which is being promoted from Dawson to Cold Creek, 20 miles distant. A franchise has been applied for in Dawson City by the Dawson Electric Company and the enterprise is said to represent an expenditure of not less than a million dollars.

At the annual meeting of the Brooklyn, N. Y., Rapid Transit Railroad Company, held in that city on January 25, the old directors were reelected unanimously, and B. W. Folger, Jr., was appointed general superintendent of the elevated lines, *vice* George E. Edwards, who has resigned. Mr. Folger enters office on February 1.

Plans are now on foot for the construction of another wheelpit and power-house for the development of 50,000 horse-power at Niagara Falls. The work is being done by the National Contracting Company, of New York city, and the generators will be furnished by the General Electric Company. The contract for the turbine wheels has not yet been awarded.

State Railroad Commissioner Kayler, of Ohio, has made an order requiring that safety gates and a derailing device be put in at the Hancock street crossing of the Baltimore & Ohio Railroad and the Sandusky Electric Company's line, at Sandusky, Ohio. This was made necessary on account of an accident that occurred there a few months ago, in which a man lost his life.

The Cincinnati Interurban Railway Company has filed with the Secretary of State a certificate for the extension of its lines. It desires to extend its main line from Cumminsville to Reading; from College Hill to Westwood; from New Baltimore to Harrison; from a point near New Baltimore to Philanthropy, on the Indiana state line. These extensions are all in Hamilton County, Ohio.

Two trolley roads furnished transportation for the citizens of Hackensack, N. J., until midnight on January 19, when some unknown person cut the wires of the main line of the Newark & Hackensack Traction Company, passing over Gott's farm at Hasbrouck Heights. This action was thought to be the result of the opposition of Mr. Gott, who refused the company's offer to allow the lines to cross his land, but the mischief-maker has not yet been discovered.

A bill has been recently introduced in the Connecticut State Senate, at New Haven, to amend the general street railway law so as to provide that the treasurers of trolley companies operating in that state must be residents of Connecticut, that the books of the companies must be kept in the state, and the returns to the railroad commission be sworn to in the state. If passed, this bill will compel changes of 10 out of 31 operating trolley companies, including several of the largest concerns.

The vibration resulting from the method of laying track in the tunnels in England is to be guarded against in the subway of the Rapid Transit Company, in New York city, and experiments are now being made on a 400-yard length of track for this purpose. The roadbed for the track is a ditch 10 feet wide and 2½ feet deep filled with 18 inches of concrete at the centre, which rises to 26 inches on the sides. On this are laid wooden sills secured to the concrete by angle-irons and on top of the former are laid 80-pound rails.

The old board of directors of the Brooklyn City, N. Y., Railroad Company were recently reelected. Edward Merritt is president; Edward White, the vice-president, and T. P. Swin, secretary and treasurer. The others are E. H. K. Belcher, Eugene Britton, R. L. Edwards, Henry Evans, S. L. Husted, Jr., David G. Legget, Frank Lyman, Edward Merritt, Charles M. Pratt, George H. Prentiss, Alonzo Slote, James Timson, Edward D. White. All served on the board last year with the exception of Henry Evans, president of the Continental Insurance Company, who was chosen in place of the late Mr. Bergen.

Some Gigantic Transformers.

The rapidly increasing use of polyphase current in power plants of great size is creating a demand for transformers of a larger capacity than have ever before been designed. The Chambly Manufacturing Company has recently placed with the Westinghouse Electric and Manufacturing Company the largest single order for transformers ever recorded.

This order comprises 20 2,750-kilowatt transformers of the air-blast type. Each of these, with an output of over 3,600 horse-power of electrical energy, weighs approximately 11 tons and stands nine feet high.

Of the 20 units, 10 are used to raise the voltage from 2,200 to 25,000 at 8,000 alternations. The input is two-phase and the output is three-phase. The remaining 10 transformers, for lowering the voltage, receive the three-phase line current at 22,000 volts and deliver out a two-phase current at 2,400 or 4,800 volts as required.

The blowers for furnishing the air blast for cooling both the raising and lowering transformers are operated by induction motors. The well-known Westinghouse methods of construction are employed in these transformers, both primary and secondary being divided into several flat coils wound with many layers, and few turns per layer, each coil being insulated separately. The advantages of this construction are that it divides the total electromotive force between the several coils, reducing proportionately the strain of each individual coil; also, it divides the electro-motive force in a single coil between many layers, thus reducing the potential between the adjacent layers. The regulation of the transformers is also improved, and the windings may be connected easily in series or in multiple, thus giving a wide range of electro-motive force. Also, in case of damage to a coil, a substitute may be provided with but little trouble, and without sending the transformer to the works.

Iron and copper have been carefully proportioned to secure the minimum losses, and the efficiency of the transformers is very high, being stated to be considerably over 98 per cent.

It is, however, not sufficient that the loss in a transformer be low when it is first installed, for, as is now generally known, much of the iron that has been used in transformers when subjected to the conditions prevailing in continued service is subject to a material deterioration, more or less rapid, with the result of a corresponding material increase in the iron losses. In some cases this increase has amounted to the doubling of the loss found in the transformer when first installed. The engineers of the company making these transformers early discovered this characteristic and at once began a careful and systematic study of the subject, with the ultimate result that there was established a special and thorough process for the manufacture and treatment of transformer iron. Entire success was attained in producing an iron at once capable of high magnetization with comparatively little energy, and having a stable character completely resisting the tendency to deteriorate in service, with consequently increased losses.

A peculiar feature of these large transformers is the change effected in them from two to three-phase and from three to two-phase current. This change is secured by means of the special windings, invented by Mr. C. F. Scott, which greatly increase the flexibility of two and three-phase methods of transmission.

New Directors of the Erie Telephone Company.

The following is a complete list of directors of the Erie Telephone and Telegraph Company as elected recently. We classify the directors with interests represented as follows:

Representing Old Colony Trust Company Syndicate—Gordon Abbott, Walter Abbott, Philip Dexter, Wm. Endicott, Jr., Frederick A. Farrar, E. E. Foye, Reginald Foster, Francis R. Hart, T. J. Harper, J. A. Parker, E. A. Phippen, J. G. Stearns, Chas. S. Tuckerman. Old board—Albert B. Chandler, Charles J. Glidden, Davis S. Greenough, J. W. C. Pickering, A. C. Russell. Telephone, Telegraph and Cable Company of America—Charles E. Adams, Frank A. Cutting, J. L. Jones, Wm. J. Latta, Martin Maloney, Frank Tilford, Henry R. Wilson.

The above gives the Old Colony Trust Company 13 of the 25 directors.

The retiring directors are as follows: Representing the Telephone, Telegraph and Cable Company—George Crocker, Harrison E. Cawtry, Daniel O'Day, John B. Stauffer, Charles W. Morse and W. H. Gelshennen. Representing the old board—John C. Burke, Wesley A. Gove, Jas. H. Mills, Levi Sprague, Harvey A. Whiting.

It is proposed to shortly reduce the present number of directors to about a dozen members, the Old Colony Trust Company still controlling the board.—*Boston News Bureau.*

A Telephone Man of 1877.

To the Editor of Electrical Review:

I have read with considerable interest the article in your issue of January 12 on the history of the development of the speaking telephone. One of the pioneers in the telephone business, who did as much, if not more, to introduce it to the public than any other person connected with it in the early days of its history, was Mr. Edwin T. Holmes, who originally placed the telephone before the business public in Boston as early as May or June, 1877, and I have in my office a photograph of the first switchboard used for this purpose, bearing the date of May, 1877.

Mr. Holmes was at that time the owner of a burglar-alarm central-office system in Boston, and used this switchboard in connection with some of the banks who were connected with his central office for protection against burglars. The same wires were used for the telephone system as were used for protection.

The switchboard was a small Western Union pin switch, and the original board is now in the office of the Holmes Electric Protective Company, at Boston.

In July, 1877, Mr. Holmes introduced to the Boston public a telephone system for ordering expresses by means of a central-office system, and this express system, so-called, is in daily use to-day in Boston, and is the only system of the kind, so far as I am aware, in use in the United States.

The writer became connected with the telephone business on October 11, 1877, with Mr. Holmes, at Boston, and remembers well the energy and foresight of Mr. Holmes and the difficulties and impediments experienced in the early days of the telephone business in placing it before the telephone-using public.

It seemed proper to me that the above facts should be placed before you in order to complete your history of the telephone.

N. W. Lillie.

Boston, January 18.

OBITUARY.

Mr. George H. Rae, the oldest son of Frank B. Rae, the electrical engineer of New York city, and formerly of Detroit and Chicago, was killed in action on December 30, 1900, at Kuion, Luzon, P. I., while serving with Company A, Battalion of Engineers, U. S. A. Mr. Rae was 28 years old and had been in the Engineer Corps since December, 1899. He was formerly connected with the Crane Elevator Company, in Chicago, and afterwards with the Helena Power and Lighting Company, of Montana.

Views, News and Interviews

A labor-saving device which will be viewed with something akin to terror by the children is an electric spanking machine which is said, when applied to the right place, to carry instant conviction, repentance and regeneration with it.

Despatches from Pretoria, South Africa, state that 80 Boers raided the town of Brak Pan recently, putting a guard over the employés of the electric power plant while they wrecked the machinery and dynamos. The works belonged to a German company supplying the suburbs of Johannesburg and mines in the vicinity with light and power.

Ladies are supposed to take up more room in a car than men and a contemporary has this to say about it:

"What is the seating capacity of this car?" asked the curious passenger.

"Well, that depends," answered the conductor, guardedly.

"Depends on what?"

"On the people. If you want an estimate I should say that its seating capacity is about 28 men or 16 women."

A few days ago a piece of iron fell into the slot of the underground trolley line on Park row, breaking the circuit of the electric current and blocking the cars for about 20 minutes. The hour was half-past five in the afternoon, which is practically the busiest part of the day, and the crowds of people who are on the cars and in the street were somewhat alarmed at the five small explosions which followed the short-circuit, but no serious damage was done.

The motorman is supposed to have his own troubles—and he has. But the cynical passenger is said to have remarked, when asked if he did not feel sorry for the poor fellow who has to stand outdoors, practically motionless, in all sorts of bitter weather, that "He has the fun of going right along and leaving me on the corner wishing a philanthropic impulse would seize some conductor and cause him to let me ride. The motorman may have to stand outdoors, but he at least gets a change of scene."

According to a Boston paper, the first electrocution in the state of Massachusetts will take place in the week beginning Sunday, April 17, the criminal being an Italian laborer by the name of Luigi Storti. Storti will have the unenviable notoriety of being not only the first man to be electrocuted in Massachusetts, but the first Italian to meet capital punishment in Suffolk County. He is said to be superior in many ways to the majority of his countrymen who have emigrated to the United States, and was formerly a sailor in the Italian navy.

A southern paper suggests a scheme by which train robberies could be in large measure prevented, or, at least, rendered less easy of successful fulfilment. The electrical engineer who proposes the plan advocates means for extinguishing every light in the train in case of alarm. This would make it necessary for the bandits to move in large numbers, as it would require several of them to guard the doors of the cars to prevent the passengers from escaping and giving the alarm. The suggestion seems to have some merit, as either gas or other lights are easily cut off whenever necessary.

An electrical engineer, in speaking of deaths resulting from shocks by high-tension currents, recently told a story which seemed to prove that the electric current is not necessarily fatal to human or animal life. "A few years ago," said the engineer, "a dog in our town was shocked until every one supposed he was as dead as an animal possibly could be. Then the people who were experimenting with him dug a hole and buried him completely, so that only his nose was above the surface of the ground. Then they turned a hose on the grave and saturated the surrounding earth thoroughly. In a few hours the dog was apparently as lively as ever and lived for three or four years afterwards. My idea of the effect of the electric current is that it polarizes the cells of the body, temporarily stopping their functions, but if by artificial means these functions can be brought into operation again the subject will undoubtedly live. I do not believe that any man who was ever electrocuted at Sing Sing was dead when he was placed upon the dissecting table."

Wall Street and the Electrical Stock Market.

On the New York Stock Exchange, General Electric closed the week at 188 bid and 189 asked, showing a gain of 2 points. Metropolitan Street Railway, of New York, closed at 162½ bid and 162⅝ asked, showing a gain of 2¾ points. Brooklyn Rapid Transit closed at 77⅞ bid and 78 asked, indicating a gain of 2⅝ points. Third Avenue Railroad closed at 120 bid and 121 asked, showing no change in the bid price and a loss of 1 point in the asked price. Manhattan Railway, of New York, closed at 116¼ bid and 116⅜ asked, indicating a gain of 4¼ points for the week. At a special meeting of the stockholders of the North American Company, held this week, the readjustment of its affairs was consummated. About two-thirds the entire stock issued voted in favor of the measures. The capital stock of the company has been reduced to $12,000,000, and the board of directors increased from nine to twelve. As reconstructed, the board of directors consists of the following: George R. Sheldon, Charles W. Wetmore, William Nelson Cromwell, Robert Bacon, Edmund C. Converse, Charles A. Spofford, J. H. Herrick, J. R. Delamar, of New York; Henry C. Payne, Charles F. Pfister, John I. Beggs, of Milwaukee; A. Q. Keasbey, of New Jersey.

On the Boston exchange, American Telephone and Telegraph closed at 161 bid and 162 asked, showing a gain of 4 points. Erie Telephone closed at 58 bid and 60 asked, indicating a loss of 7 points for the week. The Massachusetts savings banks are said to be the largest buyers of the new Erie Telephone five per cent notes. The Erie notes are accompanied by a personal note of three persons for an amount equal to the notes purchased. The banks through this method purchase the personal notes and hold the Erie notes as collateral. Both notes bear the same date of maturity. Over $2,000,000 of the $7,000,000 of notes issued have been sold to savings banks. The Boston Stock Exchange has given notice that the Erie Telegraph and Telephone Company's trust certificates have been admitted for quotation on the unlisted sheet. The old stock has been dropped from the list, but can be traded in when specified. New England Telephone was not quoted.

On the Philadelphia exchange, Electric Storage Battery was not quoted. Electric Company of America closed at 8⅛ bid and 8¼ asked, showing a loss of ⅝ point. Union Traction closed at 33¾ bid and 34 asked, indicating a loss of ⅜ point for the week.

On the curb, or outside market, in New York, Electric Vehicle closed the week at 15 bid and 18 asked, showing a gain of 1 point. Electric Boat closed the week at 29 bid and 29½ asked, indicating a gain of 1 point. Consolidated Equipment closed at 11¼ bid and 11½ asked, showing a gain of ¼ point for the week.

Wall street, January 26.

Changes in Underwriters' Rules.

At the meeting of the National Board of Fire Underwriters, recently held in New York, the voltage classification of low-potential systems was changed from 300 volts or less to 500 volts or less, and modifications of the rules applying to low-potential systems were discussed and referred to a special committee for final decision, and it is expected will be settled and copies of new rules published within two or three months.

This change permits the general use of a three-wire, 440 to 480-volt system, using 220 to 240-volt lamps and appliances on each side of the system.

The neutral wires of such three-wire systems are to be of the character formerly specified for two-wire, 220-volt systems.

The three-wire service can be carried into buildings and through main fuse, meter and service switch, in the manner formerly used with 220-volt, three-wire systems, but from that point the two sides of the circuit are required to be run separately so as to avoid having more than 250 volts at any one centre of distribution. This, however, permits the locating of two panel or distributing boards next to each other, but separated by a partition or reasonable space, and connecting service from each of them to lights and appliances in the same room, thus permitting such a system of distribution of light and current as will maintain the system as a whole in the most perfect balance possible.

With this system, direct-current lighting service can cover a very much larger area than any direct-current service heretofore permitted by the insurance rules, and will consequently prove a great advantage to companies who wish to operate to a distance of not exceeding about two miles from the power-house, yet wish to avoid the fixed losses as met with often in the best alternating systems. As this system can be operated at such a voltage as can be economically obtained from railway plants using storage batteries and other necessary auxiliaries, it will be seen that it is in line with the present tendency towards a consolidation of lighting and railway properties, and will permit furnishing both railway and lighting service from one plant at much less expense and correspondingly greater profit than could possibly be done from two, and, at the same time, provide a means whereby a 24-hour service can be maintained with profit at all hours of the day and night, which has not heretofore been possible in many lighting plants contemplating day service, nor in railway plants contemplating a limited amount of all-night service.

Within the next two or three years a great many lighting and power plants now operated separately will probably be combined, and the result will be profitable to the company operating the combination, and also make possible a reduction of rates to customers.

A Daily Paper Tackles the Series Parallel Controller.

[*From the New York Times.*]

Whenever a passenger on a trolley car is forced by its sudden starting, or by an abrupt change from slow to rapid motion, to abandon all pretences of dignified composure and to indulge in such exhibitions of ground and lofty tumbling as the greater or less proximity of his neighbors will permit, he should seek for consolation in the thought that his antics mean increased profit for the transportation corporation. So, at least, we gather from as much as we can understand of a highly technical communication that appears in the ELECTRICAL REVIEW. It seems that in the early days of trolley-carring, the current was controlled by means of a rheostat. Then, of necessity, were starts gentle and acceleration of speed ditto, but "It was soon discovered that this gentle soul-soothing starting and acceleration of the cars, for some reason was a devouring cancer on the expense account. Signals were set for the electrical inventor, who was then poised aloft, absorbed in the realm of theory, and he swooped down upon the field and tackled the motor and its equipment. The struggle was short and the dear old rheostat was soon plucked out, the motor was turned topsy-turvy and finally emerged as the great money saver, the 'series parallel system,' while the old rheostat was ignominiously flung into the scrap-pile and for it was substituted the new controller, the great physical trainer of modern times." It is not for us to explain the nature of a "series parallel system," but if, as this expert declares, and as we are willing to admit, it can be done without the assumption of any scientific responsibility, the "series parallel system" saves money at the expense of comfort for the passenger, then the system in question could only be fittingly characterized by Representative Driggs. His 17-linked adjectives would be none too many for it, and possibly—just possibly—they would have as good effects upon the street-car officials as the Congressman thinks they had upon the West Point cadets.

Electric Train Lighting.

Although Germany is the birthplace of the system of gas lighting, known there, as it is here, by the name of its inventor, Julius Pintsch, it is also the country where electric train lighting is more in use than in any other country excepting Great Britain and the United States. It is surprising to know that this is the case, but a speaker at a recent meeting of the Electrotechnical Association, held in Berlin, made the statement that in Germany about 8,000 railway carriages had been equipped for electric lighting. Consul-General Mason, at Berlin, in a recent report to the Bureau of Foreign Commerce, of the State Department, makes the statement that electric lighting has been adopted since 1893 for the postal cars on the state railways in Germany, and that electric lighting is all but universal for that class of equipment, for the reason that it has been found that the comfort, health and eyesight of the employés were seriously compromised by the system of gas lighting which had previously obtained. The example of the Royal and Imperial trains, which are all electrically lighted, has suggested the very natural inquiry as to why those for the people are not similarly protected. The government is naturally opposing this concession to public opinion, for the reason that it would involve a very large expenditure to equip its entire rolling stock for electric lighting. To this utterance the Electrotechnical Association has responded that electrical science is quite prepared to meet this demand upon it and the press has answered that the lives of the people are more precious than a few millions of marks.

As an outcome of the discussion of this question is the fact that electric lighting of railway carriages is much more general in Continental countries than is usually supposed. Besides Germany, Austria has made considerable progress in electric train lighting; Switzerland is quite prominent in this respect, and on Swedish and Danish lines it is rather the rule than the exception. France has adopted a system which seems to give satisfaction, and Italy is not far behind in this respect. At the recent session of the International Railway Congress, in Paris, the question of train lighting was presented in very able reports, and the consensus of opinion was stated in distinct terms in favor of electric lighting for railway trains as most desirable in every respect and preferable on the grounds of efficiency, economy and safety —conclusions which must appeal to the intelligence of our people who are not accustomed to take second place in the line of advancement and progress.

Telephone and Telegraph

The Home Telephone Company, of Niagara Falls, expects soon to extend its wires to Echota, La Salle and the Tonawandas.

Solomon, Kas., will have a new independent telephone exchange in operation before February 1 if present expectations are fulfilled.

Wire is being strung for the Cumberland Telephone Company, at Elora, Tenn., on the line which is to connect Winchester with Fayetteville.

The development of all the exchanges of the Pacific Coast Telephone Company, having 300 subscribers or more, is seven per cent of the population.

A franchise has been granted by Plymouth, Wis., to the Summit Telephone Company, which has recently been incorporated by Henry Timms and others.

After having been refused nearly a dozen times, a franchise has been granted to the Pennsylvania Telephone Company to extend its lines through the town of Hanover.

Work has been begun on the Westerville, Ohio, telephone line, which is to connect that town with adjoining villages and run spurs to various farms in the vicinity.

The Farmers and Merchants' Telephone Company, of Warsaw, Ohio, has increased its capital stock from $5,000 to $15,000. The officers are J. P. Darling, president, and S. C. Kirsner, secretary.

A certificate of increase to its capital stock was recently filed at Trenton, N. J., by the Keystone Telephone Company, of Philadelphia, Pa., which increased its capital from $2,000,000 to $10,000,000.

Early in the Spring a telephone line will connect Carlisle with Keyesport, Tamalco, Wisetown and Jamestown, all in Illinois. The line will probably be operated in connection with the Central Union system.

The New England Telephone and Telegraph Company has declared a regular quarterly dividend of $1.50, payable February 15. Transfer books will be closed from February 1 to February 14, inclusive.

A charter has been granted in Illinois to the Galesburg Union Telephone Company, whose capital stock is $100,000. The incorporators of the company are John Poole, L. W. Cutler and L. R. Lockwood.

Contracts for the reconstruction of the Standard Telephone Company's Langhorne, Pa., exchange have been awarded and the apparatus which is to be installed in the central station will be of the latest and most improved nature.

Advices from Cincinnati, Ohio, state that the work of changing over the system of the local telephone company, which has been in progress for a year past, has now been completed and a thoroughly modern and improved system is in operation.

The Liberty, Plainville & Hull Telephone Company has recently asked the authorities of Quincy, Ill., for permission to enter that town. No definite decision has been made, but it is expected that the requested permission will be granted.

A contract has been closed at Guntersville, Ala., between R. A. Moore, local manager of the Bell Telephone at Huntsville, and John Drake, to establish a complete exchange with a metallic circuit in Guntersville. Thirty-five subscribers have been promised to start the exchange.

The Swanton, Ohio, Telephone Company has been incorporated with a capital stock of $10,000 by P. J. Lenhart, F. A. Stuempel, F. J. Spencer, Charles F. Stolzer and Haven T. Brigham. They will operate an exchange in Swanton, with toll lines in Fulton and Lucas counties and connecting with Toledo.

Reports from Columbus Junction, Iowa, notice the organization of a new telephone company which will be known as the Rural Telephone Company. It has nine miles of wire already strung accommodating 13 subscribers, who paid $18 apiece for its construction. Swedish-American instruments are used.

A franchise has been granted by Massillon, Ohio, to the Stark County Telephone Company, which will build a line to every post office in Stark and Carroll counties, and in every town and village that will warrant an exchange. The line between Massillon and Alliance by way of Canton is expected to be in operation within the month.

Creditors of the Mississippi Valley Telephone Company, of St. Paul and Minneapolis, Minn., have consented to a sale of the company, and it will be disposed of in the near future to meet two mortgages, one for $80,000 and the other for $60,000, both of which were due before February 1. Such arrangements have been made with the holders of the mortgages that they will not foreclose. The capitalists who are interested in the purchase are E. H. Moulton, John S. Pillsbury, John Martin and others, all of Minneapolis.

A company is being organized in Salt Lake City, Utah, to enter the local telephone field as a competitor of the Rocky Mountain Bell Telephone Company. It will be known as the Utah Home Telephone Company, and its promoters expect to furnish service at lower rates than are allowed at present, and will expend $300,000 in making their system practical.

A wireless telephone conversation was recently held between Greenport, L. I., and Shelter Island. The two young electricians who conducted the experiment have been testing their apparatus for some time past and claim now that they have succeeded in making wireless telephonic conversations easy and successful with their simple and yet ingenious apparatus.

Knoxville, Tenn., has another telephone company known as the Southern Telephone Construction Company. Its organizers are W. O. Rhode and W. S. Roberts, of Knoxville, and Charles L. Meyers, of Nashville, who, until recently, were connected with the Cumberland Bell Telephone Company in executive capacities. The new company is an independent concern.

Long-distance connection between Cheneyville, La., and New Orleans, Alexandria, Memphis and other distant towns is soon to be assured by the Cumberland Telephone and Telegraph Company, which has been at work in Cheneyville regarding an exchange to be connected with Bunkie which, when put in operation, will effect the long-distance communication.

Reports from Sodus, N. Y., state that on January 11 the Empire State Telephone Company absorbed the local telephone exchange. The coming of the Rochester & Sodus Electric Railroad Company "destroyed the switchboard of the local exchange and damaged the system. The local people were about to install a new system" when the Empire stepped in and bought them out.

The expected Monongahela Valley telephone connections of the Pittsburgh & Allegheny Telephone Company, of Pennsylvania, have been arranged to go into operation on February 7. They will have 10 lines to Pittsburgh by way of the South Side and 10 to Fayette by way of Braddock and Wilkinsburg. By means of this

arrangement the company will be connected with about 3,000 telephones in the valley.

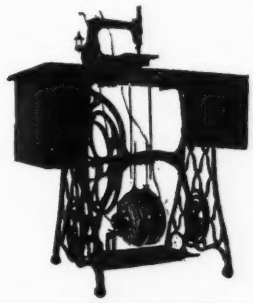
Officers were elected for the ensuing year at the recent annual meeting of the Black River Telephone Company, of Booneville, N. Y. The new officers are: President, H. C. Markham; vice-president, F. C. Meyers; secretary, S. C. Capron; treasurer, Benjamin Gauter; superintendent and manager, J. J. Domser; directors, H. Gauter, David Swancott, Frank Harrington, F. C. Meyers, Philip J. Domser, S. C. Capron, H. C. Markham and J. J. Domser.

The newspapers of Seattle, Wash., have been devoting considerable space recently to the subject of telephone franchises and contracts, and in the *Times* of January 11 the city authorities are advised to delay definite action until after they shall have thoroughly digested the good points which are alleged to be contained in the Hunt franchise measure, which is said to be unlike the McGroarty and Sunset franchises in that it is more beneficial to the city.

The Cumberland Telephone Company, of Tennessee, is stated to have recently closed an option it had with a Bristol company for telephone lines between Bristol, Bloomingdale, Peltier, Blountville and Indian Springs, Tenn., and to Gate City, Va. This purchase practically controls the entire telephone business in the upper portion of eastern Tennessee for the Cumberland company, which on January 2 took formal possession of its new building at the corner of Seventh and Cherry streets, in Chattanooga.

Prof. Reginald A. Fessenden, of Pittsburgh, Pa., was recently in Norfolk, Va., making some experiments in wireless telegraphy along the coast at stations between Capes Hatteras and Henry. These experiments mark the first attempt of the government to communicate storm warnings to vessels at sea when off those dangerous points on the coast. Professor Fessenden's idea is also to send storm signals to the life-saving stations throughout the East by this means whenever the ordinary telegraph wires are disabled as is frequently the case. The work is being done in connection with the United States Weather Bureau, with which Dr. Fessenden is connected, and if the tests are successful the entire Atlantic coast will be equipped according to his ideas.

A fine new switchboard was put in operation on the evening of January 25 in the Seneca telephone exchange of the Bell Telephone Company, of Buffalo, N. Y. The switchboard was built at a cost of $100,000 and is of the automatic type. When the old board was disconnected, the "centrals" hurried from their seats there and took their positions at the new one, which was so swiftly and easily connected that within 30 seconds it was in full operation. The most interesting part of the whole affair was that the new board and practically an entire new central-station service was inaugurated without in the least disturbing the old system. Manager H. W. Pope is said to have announced that it would have been much easier to install an entirely new plant, starting from the beginning, than it was to make the transfer.



AN INDUCTION MOTOR FOR OPERATING SEWING MACHINES.

Successful experiments are said to have been made in the forest of St. Germain, France, by M. Emile Gautier and M. Maiche, who have confidently announced that the "first step has been made in the discovery of wireless telephony." The transmitter was in a house just on the outskirts of the wood and was connected with the earth in a manner very similar to the familiar lightning-rod connection. Two iron posts, 90 feet apart and connected by wire, were planted in the earth about 1,000 yards away. The system was so simple and worked with such a degree of success that voices and other sounds at the transmitter were distinctly and clearly heard at an ordinary telephone receiver attached to one of the posts. M. Maiche will not give any particulars regarding his system of discovery, but has announced that the communication is in a straight line, being unlike the Marconi system of wireless telegraphy by wave currents. The current used in his experiments is said by the inventor to be "circuit current," virtually enabling a given spot to be accurately aimed at, and if the receiver is not placed within the plane of the current there will be no transmission, receivers on both sides of the line being unaffected. The announcement has not been made by any scientific association, the above information coming from press telegrams in daily newspapers.

An Induction Motor for Operating Sewing Machines.

The accompanying illustration represents an interesting application of small induction motors to family sewing machines as recently made by the Emerson Electric Manufacturing Company, of St. Louis, Mo. The motor is attached to the frame of the sewing machine a little above the treadle and under the table, leaving the top of the machine unobstructed, and not tending to throw any oil on the work being handled on the machine. The speed is entirely under the control of the operator, and depends upon the position of the treadle. The principle upon which the motor is used is to operate its pulley as a belt tightener. When the foot is removed from the treadle a spring throws the latter into its upward position, carrying the motor away from the belt. As pressure is put upon the treadle the motor is brought more and more tightly into contact with the belt, thus speeding up the machine. During the whole time of operation the motor is allowed to run, very little current being consumed when it is not driving the machine.

The motor, being of the induction type, has no brushes or commutator and consequently is free from small parts requiring adjustment and repair. The type illustrated is intended for the operation of family sewing machines only, and is not made for factory machines.

Minneapolis General Electric Company.

At the recent annual meeting of the stockholders of the Minneapolis General Electric Company, held in Jersey City, N. J., the following directors were elected: E. S. Webster, E. Wadsworth, M. B. Koon, H. K. White, E. A. Merrill, C. A. Stone, L. S. Cushing, Russell Robb and J. B. Dill. These directors held a meeting at which the following officers were elected: President, M. B. Koon; treasurer, E. S. Webster; secretary, E. Wadsworth. A dividend of $3 per share was declared payable February 1 to preferred stockholders of record January 21.

The First Automobile.

Our lively French contemporary, *La Locomotion Automobile,* says: "A learned person has discovered, while delving in the files of the city of Antwerp, that, in 1479, the communal treasurer was authorized by the magistrates of the town to pay a bonus of 24 livres d'Artois to a man named Gilles de Dom as an appreciation of his gift to the city of a 'carriage set in motion by mechanical means only.'"

Corporation News

CUBA, N. Y.—Cuba Telephone Company. $12,000.

JEFFERSON CITY, MO.—Missouri Electrical Company. $20,000.

MILWAUKEE, WIS.—Rock River Electric Company, of Beloit. $50,000.

INDIANAPOLIS, IND. — Sydney Telephone Company, of Sydney. $3,000.

SALT LAKE CITY, UTAH—New Light, Heat and Power Company. $24,000.

DOVER, DEL. — Overland Telephone Company, of Lehighton, Pa. $15,000.

AUSTIN, TEX.—Fayette County Telephone Company. $5,000. Incorporated by Leo Freed and others.

SACRAMENTO, CAL.—Sacramento Electric Light and Power Company. $200,000. Paid-up stock, $700.

LOUISVILLE, KY.—Nicholasville Home Telephone Company. $10,000. Incorporators: John H. Welch and others.

JEFFERSON CITY, MO.—Davies County Telephone Company, of Gallatin. $5,000. Incorporated by C. J. Bain and others.

SPRINGFIELD, ILL. — Thayer Electric Company, of Peoria. $25,000. Incorporators are R. Lester Thayer and others.

SPRINGFIELD, ILL.—Warrenburg Telephone Company. $5,000. Mary P. B. Cowen, C. J. Tucker and others, incorporators.

RALEIGH, N. C.—American Telephone and Telegraph Company. $15,000. A. B. Andrews, Jr., and others, incorporators.

EVANSTON, ILL.—The Yaryan Heating and Electrical Company, of Evanston, has increased its capital stock from $2,500 to $400,000.

SPRINGFIELD, ILL.—Sullivan Electric Company, of Sullivan. $50,000. Incorporators: J. H. Baker, W. A. Steele and J. J. Patterson.

DULUTH, MINN.—The Duluth Telephone Company has certified to an amendment of its charter raising the limit of its indebtedness to $300,000.

INDIANAPOLIS, IND. — Fort Wayne & Southwestern Traction Company. $600,000. Incorporators: C. C. Miller, W. M. Moran, N. D. Doughman.

CHATTANOOGA, TENN.—Southern Telephone Construction Company, of Knoxville. $25,000. Incorporated by W. O. Rhode, W. S. Roberts and others.

HARRISBURG, PA. — New Castle & Youngstown Street Railway Company; $50,000. New Castle & New Brighton Street Railway Company; $40,000.

COLUMBUS, OHIO — Anness - Freeman Manufacturing Company. $25,000. To manufacture electrical supplies. W. H. Anness, W. P. Freeman and others, incorporators.

AUGUSTA, GA.—St. Petersburg Telephone Company. $10,000. T. C. Parker, W. B. Birch and others, the incorporators of the company, will soon establish exchanges in Macon.

COLUMBUS, OHIO—Recent incorporations in Ohio include the following: Railway Supply and Manufacturing Company, Cincinnati; $100,000. People's Telephone Company, Sardinia; $2,500.

MINNEAPOLIS, MINN.—P. F. Crafts, manager of the International Electric Company, has been appointed by the court receiver under the mortgage for $40,000 recently brought on foreclosure proceedings.

COLUMBUS, OHIO—The Citizens' Telephone Company of this city has filed an additional mortgage to the State Savings Bank and Trust Company of this city, to secure the payment of its five per cent 20-year bonds.

SCRANTON, PA.—A franchise has been granted to W. W. Watson and his colleagues for the Central Rapid Transit Railway Company, which was incorporated in Harrisburg, with a capital stock of $50,000, a week or so ago.

CHATTANOOGA, TENN.—Chattanooga & Lookout Mountain Railroad Company. $250,000, and a bond issue for the same amount. The officers are S. W. Devine, president; R. W. King, vice-president, and W. Carey, secretary.

MILLVILLE, N. J.—The Bridgeton & Millville Traction Company has recently, through a firm of brokers in Philadelphia, advertised $350,000 worth of its bonds for sale. The company's total earnings are stated to be $85,485.79.

UTICA, N. Y.—The county clerk, among other annual reports, has received that of the Central New York Telephone and Telegraph Company, of Utica. The report shows a capital stock of $800,000, all paid up; debts, $200,000, assets, $400,000.

SHARON, PA.—Sharon & New Castle Electric Street Railway Company. $110,000. The incorporators are W. J. Thompson, Youngstown; C. W. Dahlinger, Van Vorhees, A. Powell, Pittsburgh; S. W. Thomas, Etna, and A. H. Mercer, Allegheny.

MANKATO, MINN.—At a recent meeting of the Mankato Citizens' Telephone Company the directors decided to increase the company's capital stock to $100,000, to meet the expense which will be incurred by the extensions which have been planned for increasing business.

BLOOMINGTON, IND. — Representatives of the American Light and Water Company, of Indianapolis, have recently purchased the Jenney electric light plant, of Bloomington, paying $20,000 for it, and securing a 30-year franchise from the city at $80 per lamp, with 60 lamps in the contract.

BENTON HARBOR, MICH.—A consolidation has been effected between the Benton Harbor and St. Joseph electric systems, which will be known as the Benton Harbor & St. Joseph Electric Railway and Light Company. The new corporation is offering $200,000 of its bonds. Railroad lines have 10½ miles of track, and enjoy all the street railway privileges of both cities.

AUSTIN, TEX.—Twin City Union Railway Company. $1,000,000. The incorporators are W. D. H. Washington, of New York city; G. Van Ginkle, of Dallas; I. M. Earle, of Des Moines, Iowa; E. C. Gambrell, of Dallas; E. T. Moore, of Dallas; Fred Howard Porter, of Dallas; C. H. Briggs, of Dallas; Turner A. Beall, of New York city; J. T. Voss, of Fort Worth; L. M. Callaway, of Dallas; Ben. O. Smith, of Fort Worth; J. W. Spencer, of Fort Worth.

ALBANY, N. Y.—Rochester & Eastern Rapid Transit Railway Company, principal offices, Canandaigua; to build a street railroad 45 miles long from Brighton to Geneva, with a branch from Pittsburgh to Fairport. $500,000. Directors are Albert F. White, John Winter, A. Lindsley Parker, C. F. Andrews and Oliver H. Law, of Detroit; Eugene H. Satterlee, of Pittsford; Oscar N. Crane, of Canandaigua; Spencer F. Lincoln, of Naples, and John F. White, of Buffalo.

ALBANY, N. Y.—Atlantic Telephone Company. $5,000,000. To maintain a telephone system between New York, Albany, Syracuse, Rochester, Buffalo and intermediate points and a long-distance system to connect with the principal cities in the United States and Canada. The directors are William H. Stayton, of Yonkers; John A. J. Campbell, Charles B. Reid, Arthur B. La For and James G. Shaw, of New York city; George H. Mann, of Brooklyn, and Warren L. Sawyer, of Nyack.

COLUMBUS, OHIO—Cleveland, Ashland & Mansfield Traction Company; $10,000; the incorporators are C. V. Hard, T. F. Disette, S. T. Everett, Richard W. Parmelly and E. J. Kennedy. The Columbus & Southern Electric Railroad Company; $1,000,000. Citizens' Telephone Company, West Unity, certifies to an increase to its capital stock from $5,000 to $15,000. Conneaut & Western Railroad Company; $10,000. Eastern Liverpool & Youngstown Railroad Company; $15,000. Toledo Telephone, Telegraph and Message Company; $25,000. Buckeye Traction Company, Buckeye; the incorporators are: H. V. Flickinger, R. V. Sears, A. J. Scott, C. Feiring, S. J. Kibler and W. A. Blicke. Dayton & Northwestern Traction Company; $10,000. Central Market Street Railway Company, of Columbus; $10,000; Benjamin Monatt and others, incorporators. Geneva Automobile and Manufacturing Company, of Geneva; $100,000. Liberty Centre Telephone Company; $10,000. Steubenville Traction and Light Company, of Steubenville; $500,000.

Automobiles

A "professorship of automobilism" is said to have been established by the Association Philotechnique, of France.

A New Haven, Ct., firm is said to be interested in automobile hearses, and a newspaper says that people are "dying to ride in them."

The People's Automobile Company, of Cleveland, has changed its name to the People's Automobile Manufacturing Company and its purposes, so as to authorize it to make such machines.

Russian roads are so illy paved, even in the large cities, that automobiling is hardly likely to become popular to any extent until the streets and ways are better constructed. There are but few of the machines in the Empire.

La Locomotion Automobile, Paris, comments, in its issue of January 16, upon the unification of automobile types and designs. The classes of vehicles mentioned are the motocycle, voiturette, petite voiture and grosse voiture. M. Lucien Périssè, an engineer, is the author of the article. The same paper contains a brief account of the status of the automobile industry in Europe.

United action has at last been taken by prominent automobile clubs to establish sign-posts on the principal roads leading from New York throughout the eastern states. The movement involves considerable expense, which will be borne by the following clubs jointly: Automobile Club of America, Automobile Club of Baltimore, North Jersey Automobile Club, Philadelphia Automobile Club, Long Island Automobile Club, Westchester Automobile Club, Rhode Island Automobile Club, Automobile Club of Bridgeport, Massachusetts Automobile Club, Brooklyn Automobile Club, Pennsylvania Automobile Club and Automobile Club of New Jersey.

The authorities of the Pan-American Exposition, at Buffalo, N. Y., are anxious to have the Automobile Club of America choose Buffalo as the terminus of the Endurance Test which the club proposes to hold next Fall. One of the inducements offered is a 50-mile road race, to be run on a stretch of road near Buffalo, which is said to be as well fitted for a speed contest as any road in the country. The managers state that they do not wish to encourage promiscuous road racing, but would like to have some demonstration of speed of a local character at least. They promise to have the course properly patrolled and see that everything is to be done to make the race an entire success in every respect.

The board of governors of the Long Island Automobile Club has authorized the conditions as set forth below for the 100-mile endurance test to be held on Long Island some time during the latter part of March.

1. Endurance test to be held late in March.
2. Open to three classes,—steam, gasolene and electricity. Special prizes issued for each class.
3. Applications for entrance of other motive-powers will be received and given due consideration.
4. Course to be over macadamized roads on Long Island, including grades, levels, etc., no retracing; 100 miles within a 12-hour limit.
5. Notices of the forthcoming endurance test to be sent to all village authorities through which the course may be laid, requesting their cooperation.
6. Speed limit of eight miles through villages and towns, with a maximum speed limit of 15 miles per hour.
7. All contestants are to provide their own fuel and water, either by preliminary arrangement or by transportation.
8. Owners of electric carriages to arrange for battery relays.
9. In case of a tie between two vehicles of the same type, the best average time, taking into consideration the amount of fuel consumed, the weight of the carriage and nonstops.
10. Hill-climbing contest to take place on the grade between Jamaica and Flushing. At this point there is a grade estimated to be about 20 per cent, and about one-quarter of a mile long.
11. Entrance fee, $10 for each vehicle.
12. Entries are to be confined to self-propelled vehicles, so constructed as to carry at least two passengers seated side by side. All vehicles have to carry the full complement of passengers.
13. For entry blanks, information, etc., applications should be made to Mr. Charles W. Spurr, secretary of the club, at the club headquarters, 552 State street.

The committee in charge of this endurance is: L. R. Adams, president of the club, and chairman of Contests and Exhibitions Committee; H. B. Fullerton, chairman of Good Roads Committee; H. S. Chapin, chairman of Runs and Tours Committee; F. W. Tousey, R. E. Jarridge and J. E. Savel, members of the Contests and Exhibitions Committee; F. G. Webb, chairman of Technical Committee; C. W. Spurr, Robert Darling and A. R. Pardington.

Electromobile Competition in Berlin.

United States Consul Hughes writes from Coburg, Germany, as follows:

Dr. M. Kallmann's report on the competition of electrically propelled vehicles in Berlin is highly instructive. The battery taking the first honors weighed only 121 pounds per kilowatt-hour, while the heaviest weighed 286 pounds per kilowatt-hour. The mean weight of the 13 vehicles taking part in the competition was 1,650 pounds. Upon the assumption of a yearly total mileage of 9,500 miles, he calculates the annual maintenance cost of a battery at only 48d., or, say, a cent per mile. The smallest consumption of energy per ton-mile at the mean speed amounted to 91 watt-hours for a passenger car, a far better performance than previous records are able to show. At the highest speed, the consumption increased to 135 watt-hours. However, in the majority of cases, the demand did not vary greatly with the speed, which leads to the conclusion that, in order to obtain the greatest commercial economy of energy, the electrically propelled car should be driven at the highest speed consistent with public safety. By the high speed, the consumption of energy per car mile is not considerably increased, while the number of passengers which may be transported in a given time naturally increases with the speed. With regard to the motor best adapted for the weight to be propelled, the capacity should amount to approximately one kilowatt per ton of the rolling weight.

The Growing Telephone Industry.

A newspaper recognized as an authority on financial matters contains the following statement regarding the telephone industry, and says that the last year of the old century was a record year in many industries, which was probably influential in making it an unusually prosperous period in the development of the telephone service:

"For although the telephone is every day advancing in popularity as a helpmeet in the household, business is its mainstay. Now that a more scientific scheme of rates has taken the place of the old flat rate, the telephone service is within the reach of a vast class of people who formerly considered it an expensive luxury. The telephone habit grows very rapidly, and not only is it true that once a telephone user always a telephone user, but every new telephone user helps to make others. So the great telephone system goes on pushing its myriad wires and its active little machines into all quarters; into the retail store and the carpenter's shop, as well as into the merchant's office and the financial magnate's sanctum, into the unpretentious private house or flat as well as into the millionaire's mansion and the palatial hotel. To descend to figures the New York Telephone system gained, in 1900, over 14,000 new stations. How striking an increase this was may be appreciated when one considers that five years ago there were not as many stations as this in the New York system and that there are not much more than a dozen cities in the world to-day having telephone systems of over 14,000 stations—the gain in New York in a single year."

Industrial Notes

THE AMERICAN BRIDGE COMPANY is furnishing from one of its Chicago plants thirty-six plate girder spans for the Rio Grande Western Railway Company.

THE WESTERN ELECTRIC COMPANY, Chicago, Ill., has issued Bulletin 7009 for December, 1900. The folder is entitled "Series Enclosed Alternating Arc Lighting System," containing full descriptive matter and illustrations.

INCANDESCENT LIGHTING is having a veritable boom in this country, or else Packard lamps are becoming favorites with the users, is the story told by the Electric Appliance Company, Chicago, which has to point to something for its increase in sales.

BAKER & COMPANY, Newark, N. J., and 120 Liberty street, New York city, the well-known platinum manufacturers, have issued a handy memorandum book, bound in celluloid. A great deal of valuable information regarding platinum and engineering tables is contained between the covers.

THE JAMES KEMPSTER PRINTING COMPANY, 117-121 Liberty street, New York, is sending handsome calendars to its friends for the ensuing year of 1901. The calendars are neatly mounted upon heavy tinted cards in pale blue, orange, and black, and are stamped in silver.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., is sending out a catalogue of its rheostats and other products in a neat binder which opens lengthwise, thus enabling the book to be carried in the pocket. It will be mailed to any purchasing agent or engineer upon application to the company.

THE WARREN ELECTRIC AND SPECIALTY COMPANY, Warren, Ohio, has prepared a set of four artistic calendars embellished with Indian portraits, by E. A. Burbank, with which it is favoring its friends. The back of the calendar carries an ingenuous reminder of the qualities and merits of the "Peerless" incandescent lamps and "Peerless" transformers.

THE ELECTRIC BATTERY RENEWING COMPANY, St. Louis, Mo., has an electrochemical process of treating old battery carbons in such a manner that all salts and impurities are said to be extracted, leaving the carbon in a better condition than when new. The company guarantees that carbons after being treated will show a higher voltage and longer life than when new.

THE CLAYTON AIR COMPRESSOR WORKS, 26 Cortlandt street, New York, has issued a handsome and comprehensive catalogue of its machines, engines and other apparatus. Purchasing agents and others interested are requested to mention Catalogue No. II in their applications. The book is neatly bound and contains numerous well-executed illustrations.

THE HAZARD MANUFACTURING COMPANY, of Wilkesbarre, Pa., is sending to its many friends and customers an extremely handsome calendar composed of four sheets printed in colors, and depicting Indian heads. The company's brands of wire rope and insulated wires are advertised in a dignified manner. The Hazard Manufacturing Company's New York offices are at 50 Dey street.

THE OKONITE COMPANY, Ltd., of New York, has sent out to a number of its friends a handsome desk calendar for 1901. The front of the calendar board is adorned with a handsome high-relief cameo medallion, framed in gold, the subject being a reproduction of antique dancing figures. The inevitable semi-circular trade-mark, known to users of wire and cables the world over, is also modestly in evidence.

THE GENERAL INCANDESCENT ARC LIGHT COMPANY, First avenue and Thirty-third street, New York, has issued its Bulletin No. 74, for December, describing the mechanism and giving full particulars of the company's series enclosed arc lamp, style L3. Full descriptive matter is given in the folder, with prices and other information of interest. It will be sent upon application to any one interested.

THE ELECTRIC EQUIPMENT COMPANY, 101 West Thirty-ninth street, New York city, announces that Mr. Charles J. Klein, formerly general superintendent of the New York Electrical Equipment Company, has become president of the new concern, and will continue in the electrical equipment business at the address named above. Mr. Klein promises his individual attention to all contracts and orders, and requests the patronage of his former friends for his new enterprise.

THE NEW YORK INSULATED WIRE COMPANY, New York city, has recently issued a neat handbook of its manufacture, with pertinent extracts from the rules of the National Board of Fire Underwriters, price lists, and other matter of interest to any one who uses cables, braids, insulating materials, line wires, tapes, telegraph and telephone wires, and other similar material. The book will be sent upon application to the company, and is known as "Price List No. 21."

"GRAPHITE" for January contains a short sketch of Joseph Dixon, the discoverer of the useful properties of graphite for crucibles, stove polish and lubricating purposes. In 1827 he made crucibles out of New Hampshire graphite, while two years later, in 1829, he imported the first cargo of the Ceylonese product, which, since that time, has remained the standard for fineness and ability. "Graphite" is published by the Joseph Dixon Crucible Company, of Jersey City, N. J.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, has recently closed a contract with the Camden & Suburban Railway, Camden, N. J., for the installation of an additional battery of chloride accumulators, making the third order received from this company. The new battery substation is necessitated by the extension of the railway company's lines to Moorestown, a distance of ten miles from its power-house at Camden, and will be located at Pensauken Creek, near Moorestown. The battery will consist of 240 cells having a capacity of 200-kilowatt hours.

MR. HORACE J. STEVENS, of Houghton, Mich., has just issued a valuable compilation, which he calls the "Copper Hand-Book," and which contains 50 statistical tables, covering Lake Superior copper production, values, prices, dividends, assessments, and a very considerable amount of solid information regarding shares, mines, and other copper matter of interest and value. The book is so arranged that the different subjects can be easily got at, and aims to be a solid and unpretentious reference book. Any one who is interested in the copper situation will appreciate its value. It is bound in paper, and sold by Mr. Stevens.

THE AMERICAN SCHOOL OF CORRESPONDENCE, Boston, Mass., has recently added four new instructors to its staff, all of whom are teachers at the Massachusetts Institute of Technology. These are: William S. Newell, boilers; Joseph C. Riley, machine design; Walter S. Leland, steam engines; Charles W. Berry, mechanics, and Frank R. Swift, chemistry. In addition, the trustees have engaged Mr. Charles L. Hubbard, B. S., M. E., who has been actively associated with S. Homer Woodbridge, the heating and ventilating authority, to take charge of a new course on heating and ventilation, which is in preparation.

THE YORK MANUFACTURING COMPANY, York, Pa., has recently received from the engraver its new catalogue of ice-making, refrigerating and other machinery. The catalogue in question shows a considerable range and variety of apparatus, displaying it by means of copious illustrations in both half-tone and line cuts. The pamphlet is a very handsomely gotten up book, fully maintaining the usual Bartlett standard, and showing the machinery it advertises to the best advantage. The York company's apparatus is claimed to be particularly useful and efficient in electric plants or wherever power and light or heat are furnished by the electric current.

THE AMERICAN HARDWOOD MANUFACTURING COMPANY, of Grottoes, Va., reports that it has just completed installing an electric light plant in its works, at Grottoes, Va., and is operating with a full force of mechanics night and day, making telephone boxes and other cabinet woodwork for the telephone trade. This company has been making a specialty of the manufacture of telephone boxes for the past seven years, supplying nearly all of the large manufacturers of instruments with their woodwork. Mr. W. F. Livers, the secretary-treasurer of the company, reports large contracts on hand for woodwork of all kinds, which will keep the company busy for some time to come.

MR. GEORGE H. DANIELS, general passenger agent of the New York Central & Hudson River Railroad Company, described at length in the Brooklyn *Daily Eagle* of December 30, 1900, the luxury of travel over the lines of the Central and New Haven roads, and referred in pleasing terms to the new force—electricity—which may revolutionize present methods of light transportation, and even possibly extend to heavy railway traffic for longer distances. Mr. Daniel's article attracted considerable attention, and no one is better fitted to describe the railway situation than he, both on account of his extensive experience in railroad matters, and because he is in touch with the latest electrical improvements.

ROSSITER, MACGOVERN & COMPANY, 141 Broadway, New York, recently bought of the St. Louis Transit Company the entire stock of electric generators, machinery, etc., in one of its large power-houses. The generators aggregate nearly 2,000 kilowatts capacity. This apparatus is now for sale. This company is making a specialty of buying in large quantities apparatus of this kind, and can supply other power and lighting stations throughout the country on rush orders with almost anything that is needed. A very large business in this line of work has been built up by this company, of which Mr. Charles E. Dustin, for many years at the head of electric light manufacturing companies, is now president.

THE MICHIGAN ELECTRIC COMPANY, of Detroit, was prominently identified with the movement for increasing the voltage of low-potential systems, as permitted by rules and requirements of the National Board of Fire Underwriters, and warmly supported by the manufacturers and representatives in attendance at a recent meeting, with the result that the proposed change was adopted with almost unanimous consent. We learn that the Michigan Electric Company's interest in this matter resulted from the thorough study it had given this subject at the request of a company which desires to furnish both railway and lighting service in the best possible manner, and at the minimum operating expense, and we expect within a few months to be able to give the details of the plan decided upon by the Michigan Electric Company, which, it is expected, will soon be put into effect with most satisfactory results to the company for whom it has worked them out.